PLANT PATHOLOGY

A RECORD OF CURRENT WORK ON PLANT DISEASES AND PESTS

Published quarterly for the
Ministry of Agriculture, Fisheries and Food
Plant Pathology Laboratory
Harpenden, Herts

VOLUME 6, No. 3
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POTATO BLIGHT CONTROL TRIALS IN THE WEST MIDLAND PROVINCE, 1950-54

by W. R. ROSSER

National Agricultural Advisory Service, Wolverhampton

The experience of advisers and growers in the West Midland advisory province of England over a number of years was that a uniform policy for spraying against Potato Blight was difficult to formulate, but that it was doubtful whether *routine* copper spraying of the haulm was justified. There was very little experimental evidence available on which advice could be based and it was in order to fill this gap that these trials were initiated by the Provincial Field Experiments Committee.

EXPERIMENTAL METHODS

The trials were carried out mainly on commercial farms which were located : in Cheshire in the Northwich-Altrincham area ; in Shropshire in the Newport-Shifnal area ; in Staffordshire in the Lichfield-Drayton Bassett area, north-east of Birmingham ; in Warwickshire at Dordon, near Atherstone ; and in Worcestershire in the Kempsey Common area, about three miles due south of Worcester. In the following account the county name is used to designate the area in each county where the trials were carried out and for which the information obtained is relevant. Except for one centre in one season (Cheshire in 1954) the trials were on King Edward potatoes throughout.

There were six treatments in a 4×6 randomized block layout at each centre in each year, as follows :

1. Control. No protective spraying. No haulm destruction.
2. Protective copper spraying only.
3. Protective spraying *and* haulm destruction two weeks before lifting.
4. Haulm destruction only : by mid-August in 1951–54. (When blight was at 25 per cent on haulm in 1950.)
5. Haulm destruction only : at about the end of August.
6. Haulm destruction only : in late September, at the same time as in treatment 3.

Each of the 24 plots comprised 10 rows, 9 yards long and 27 inches apart. Where the actual row width differed appreciably from 27 inches, the length of the plot was adjusted accordingly. Whenever possible an additional blank row was left between blocks to minimize mechanical damage. The total experimental area in each trial was about one-third of an acre.

The protective spraying was done with a proprietary copper fungicide—in general, copper oxychloride (50 per cent Cu) at 5 lb per 100 gallons—applied with a knapsack sprayer at a rate of at least 100 gallons per acre. The timing of the sprayings was decided by the local officer in charge of the trial after consultation with the Provincial Plant Pathologist. As far as possible the timing of the first copper spraying was based on the occurrence of a Beaumont period. The haulm destruction was done with sodium chlorate, again by knapsack sprayer, using 30 lb per 100 gallons, applied at a rate of at least 100 gallons per acre. The dates at which both the protective and the destructive

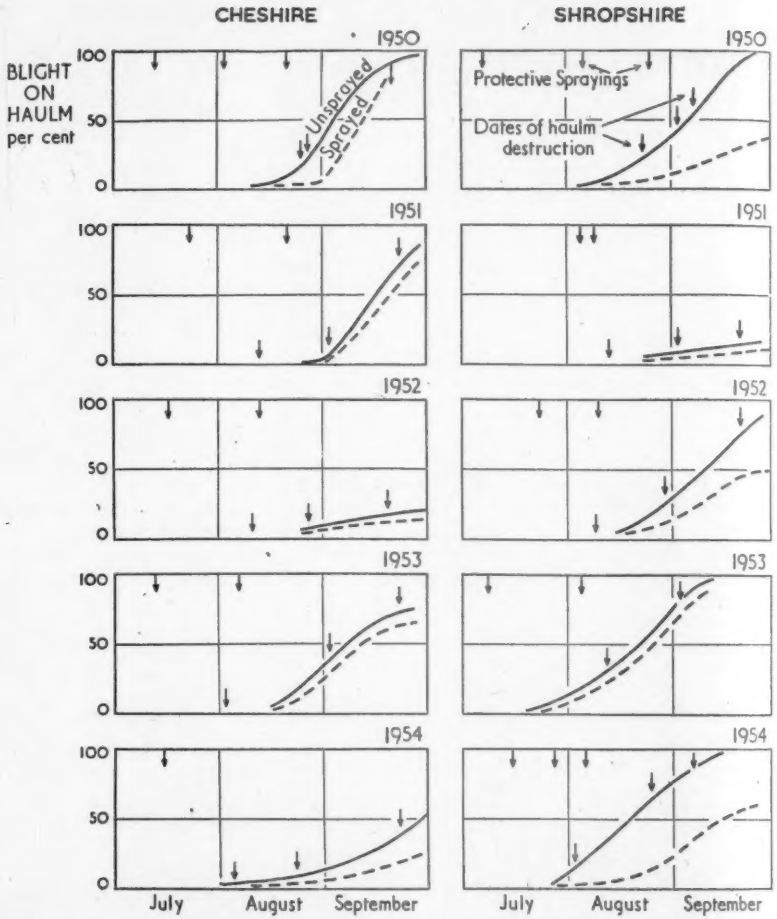

Fig. 1. Progress of blight on haulm of sprayed and unsprayed King Edward, with dates of protective spraying and haulm destruction. Cheshire and Shropshire, 1950–54.

sprayings were given, in each trial, are indicated in Figs. 1 and 2, in relation to the blight progress curves.

At harvest, the two outer rows of each plot, and 1½ yards at each end, were rejected, so that the harvested area was 6 rows by 6 yards, equal to 27 square yards or 1/180 acre. The tubers were lifted either with a mechanical digger or by hand fork, the produce of each plot being weighed, bagged, labelled and stored in a cool, dry place for 3–4 weeks. After this period of storage, 100 random tubers per cwt per plot were examined for infection by *Phytophthora infestans*. The *total* yields, in all the trials, calculated in equivalent tons per acre, are given in Table 1, and the calculated weights of blighted tubers, in cwt per acre, in Table 2.

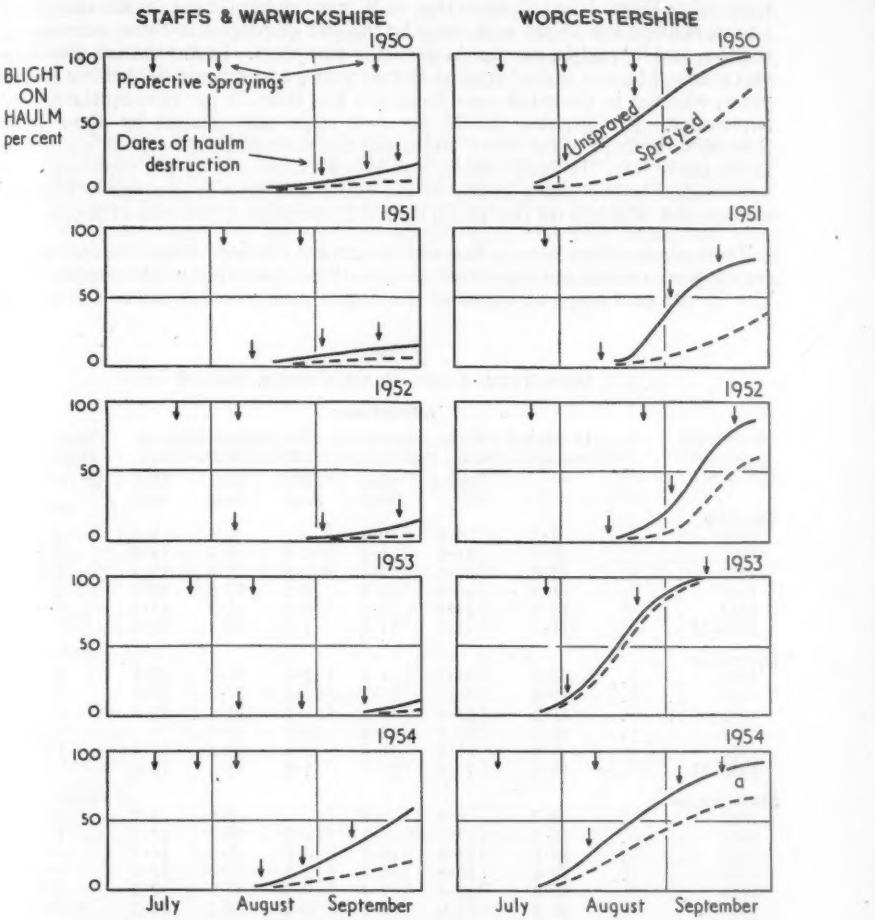

Fig. 2. Progress of blight on haulm of sprayed and unsprayed King Edward, with dates of protective spraying and haulm destruction. Staffordshire, Warwickshire and Worcestershire, 1950–54.

INCIDENCE OF BLIGHT DURING THE FIVE YEARS

Even in " blight years ", it is only exceptionally that blight attacks in the West Midland Province can be said to " begin ", or to reach the 0·1 per cent stage by the B.M.S. key, earlier than the end of July. Where protective spraying is to be done, the best date for the first spraying is usually about the third week in July.

The progress of the disease, after the outbreak and up to the 75 per cent stage at which tuber production is arrested, is generally also relatively slow, but it varies greatly according to district and season. The blight progress curves for

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these trials (Figs. 1 and 2) show that in Worcestershire blight on the unsprayed haulm reached the 75 per cent stage by the end of August in three years out of the five, and by mid-September in the other two years. In Shropshire, this stage was reached by the end of August in two years, and by mid-September in two years, whereas in the other year there was less than 25 per cent by the end of September. In Cheshire, the 75 per cent stage was reached by about mid-September in three of the years, and it was not reached by the end of September in the other two. In Staffordshire and Warwickshire the 75 per cent stage was not reached before lifting in any of the years, and only in one year (1954) did the amount of blight on the haulm exceed 25 per cent at the end of September.

These observations were in line with the results obtained in the national blight survey work carried out since 1950 (Large, 1956), and with previous experience. The 75 per cent stage of blight of the haulm rarely occurs before the end of

TABLE 1

MEAN TOTAL YIELDS AT ALL CENTRES, 1950–54

tons per acre

	Untreated Control	Copper Sprayed Haulm Destruction :		Not Copper Sprayed Haulm Destruction :			Significant Difference (P = 0·05)
		None	Mid-Sept.	Early Aug.	End Aug.	Mid-Sept.	
Cheshire							
1950	8·3	9·8	10·4	—	9·5	9·2	1·2
1951	10·6	11·4	11·3	6·5	9·5	11·0	1·9
1952	13·6	11·5	11·9	7·6	10·5	13·6	1·3
1953	11·3	10·4	10·9	6·3	10·9	10·2	1·4
1954	14·7	14·4	12·9	10·1	13·3	13·2	3·0
1950–54	11·7	11·5	11·4	7·6	10·7	11·4	
Shropshire							
1950	14·0	14·7	14·2	12·8	13·6	13·8	0·7
1951	17·4	16·0	16·2	11·1	17·8	17·9	1·8
1952	13·2	13·4	11·9	11·5	12·0	12·4	1·7
1953	14·0	14·1	13·9	14·0	14·0	—	0·9
1954	9·1	11·4	12·3	8·6	10·2	10·4	1·4
1950–54	13·5	13·9	13·7	11·6	13·5	13·6	
Staffordshire							
1950	9·7	8·9	9·6	—	9·5	9·7	—
1951	17·5	17·2	17·1	9·9	16·2	17·5	1·3
1952	15·1	13·6	14·2	10·8	14·2	14·7	1·3
1953	16·6	16·8	16·2	12·4	15·0	17·0	1·0
1954	12·4	13·4	13·4	9·3	11·3	12·2	1·3
1950–54	14·3	14·0	14·1	10·6	13·2	14·2	
Warwickshire							
1950	14·4	12·4	12·8	—	15·5	15·3	1·5
1951	13·6	13·5	13·9	3·9	12·0	14·0	1·4
1953	17·7	17·5	16·0	11·4	16·7	18·2	1·7
1954	11·4	9·8	10·4	6·8	9·6	10·6	1·8
1950–54	14·3	13·3	13·3	7·4	13·5	14·5	
Worcestershire							
1950	12·9	15·2	17·0	13·7	12·5	14·2	2·8
1951	11·8	12·3	12·2	6·6	11·4	13·0	2·2
1952	10·4	11·4	12·5	8·1	11·7	10·5	1·7
1953	10·5	10·1	9·8	9·1	9·4	10·1	2·1
1954a	14·4	16·0	15·2	12·6	14·5	15·0	0·9
1954b	14·0	14·5	14·6	10·4	13·5	14·5	1·4
1950–54	12·3	13·2	13·5	10·1	12·2	12·9	
All centres							
1950–54	13·1	13·2	13·2	9·7	12·6	13·3	

August in the West Midlands, and more often this stage is not reached until the second half of September, when the defoliation is too late to have much effect on the total yield. It will be noted, however, that at every centre and in all the years there was *some* blight on the haulm in September, giving opportunity for tuber infection.

The variation in blight incidence in different areas of the West Mildands, frequently noted during advisory work, is apparent in the range of blight progress curves in these trials. Smith (1956) found that screen humidities in Cheshire and the Welsh Marches were lower than those in other parts of the country, and though this did not necessarily mean that crop humidities were equally low, local variation in an area of generally low screen humidity will almost certainly contribute to the variation in blight incidence that has been noted.

TABLE 2

MEAN WEIGHTS OF BLIGHTED TUBERS AT ALL CENTRES, 1950–54

cwt per acre

	Untreated Control	Copper Sprayed Haulm Destruction : None	Copper Sprayed Haulm Destruction : Mid-Sept.	Not Copper Sprayed Haulm Destruction : Early Aug.	Not Copper Sprayed Haulm Destruction : End Aug.	Not Copper Sprayed Haulm Destruction : Mid-Sept.	Significant Difference (P = 0·05)
Cheshire							
1950	3	2	1	—	2	1	
1951	19	12	6	7	5	5	
1952	13	0	1	0	2	8	
1953	9	3	9	2	7	9	
1954	9	5	5	4	9	12	
1950–54	11	4	4	3	5	7	6
Shropshire							
1950	4	1	3	3	3	2	
1951	21	14	22	4	14	28	
1952	4	1	0	1	3	3	
1953	13	7	7	14	5	—	
1954	3	3	5	5	5	6	
1950–54	9	5	8	5	6	9	6
Staffordshire							
1950	28	5	4	—	11	35	
1951	28	19	8	3	8	23	
1952	1	0	0	0	1	1	
1953	18	4	3	3	4	12	
1954	21	12	9	8	16	21	
1950–54	19	8	5	4	8	18	6
Warwickshire							
1950	14	6	13	—	18	14	
1951	17	7	16	1	9	16	
1953	3	3	0	2	4	3	
1954	13	12	11	6	11	14	
1950–54	12	7	10	3	11	11	7
Worcestershire							
1950	40	22	23	16	24	29	
1951	17	18	4	2	9	13	
1952	2	1	0	0	1	0	
1953	24	6	9	5	20	28	
1954a	3	3	2	3	4	5	
1954b	4	4	2	2	2	4	
1950–54	15	9	7	5	10	13	6
All centres							
1950–54	13	7	7	5	8	12	3

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EFFECT OF PROTECTIVE SPRAYING

Protective spraying cannot be expected to give any appreciable increase in yield if the unsprayed haulm is not destroyed by blight until late in the growing period. As Table 1 shows, a significant increase of total yield as a result of spraying was obtained in only one season (1950) in Cheshire ; one season (1954) in Shropshire ; and in three seasons (1950, 1952 and 1954) in Worcestershire. There was no significant gain in any of the five seasons in Staffordshire or Warwickshire. The mean total yields for all centres and years (Table 1) show no appreciable gain from protective spraying, and no loss from burning off in late September, with or without protective spraying. It is noteworthy, however, that *protective* spraying gave a significant reduction in the weight of blighted tubers, the mean reduction (on these King Edward crops) being of the order of 6 cwt per acre for all centres and all years (Table 2).

Despite this appreciable and fairly constant reduction in blighted tubers, which must be held to the credit of protective spraying on this variety, it is evident on the showing of these trials that *routine* protective spraying every year, even on King Edward, is not economic in the West Midlands.

In the " blight years " such as 1950, 1953 and 1954, however, when the blight attack in parts of the province, notably Worcestershire and Shropshire, may reach the 75 per cent stage by the end of August, *efficient and well-timed* spraying on King Edward in these areas may result in a gain of some 2 tons of healthy tubers per acre. The point of efficiency of spraying must be stressed. Where, as in these trials in 1953, the spray timing is at fault or heavy rains quickly wash the spray deposits off the leaves, there may be little difference between the blight progress curves for the sprayed and unsprayed, and little or no gain in yield from spraying.

ESTIMATION OF SPRAYING GAINS FROM THE BLIGHT PROGRESS CURVES

According to the provisional mean bulking curve given by Large (1952) for the estimation of blight losses, the loss of potential yield when the blight attack reaches the 75 per cent stage at the end of August is about 13 per cent of the potential crop, and where this stage is not reached until mid-September the corresponding loss is 4 per cent. At the end of September the loss is nil.

The gains from spraying, as estimated by this means from the progress curves in these trials (Figs. 1 and 2),were in good general agreement with the gain as indicated by lifting (Table 1). The analysis of the estimated and actual gains for Worcestershire, the most severely affected part of the province, are given in Table 3.

TABLE 3

CORRESPONDENCE BETWEEN GAIN FROM SPRAYING AS ESTIMATED FROM BLIGHT PROGRESS CURVES AND BY LIFTING. WORCESTERSHIRE, 1950–54

	75 per cent Date		Estimated Loss of Potential Yield		Yield of	Approx. Potential	Gain from Spraying	
	Unsprayed	Sprayed	Unsprayed *per cent*	Sprayed *per cent*	Unsprayed *tons/acre*	Yield *tons/acre*	Estimated	Actual by Lifting
1950 ..	4/9	26/9	10	1	12·9	16	1·5	2·3 ± 0·9
1951 ..	20/9	30/9	2	0	11·8	13	0·3	0·5 ± 0·7
1952 ..	16/9	30/9	4	0	10·4	12¼	0·5	1·0 ± 0·6
1953 ..	24/8	27/8	19	17	10·5	13	0·3	− 0·4 ± 0·7
1954a	4/9	20/9	10	2	14·4	16	1·3	1·6 ± 0·3

In this table the estimated losses for the several 75 per cent dates are read off as closely as possible from a plotting of the mean bulking curve, and the "potential yields" are taken as about the highest yields actually obtained in the trials (with an extrapolation for 1953). It will be seen that the gains as estimated from the curves were of the right order in each year, and no less accurate then the estimates obtained by lifting, which were subject to very considerable standard errors.

It is reasonable to assume that haulm destruction will have much the same effect in reducing the crop as a blight attack that stops growth by the same date. The sets of yield figures obtained in these trials for haulm destruction in early August, the end of August and mid-September respectively, thus provide valuable information on the mean rate of bulking of King Edward in the West Midlands. The mean figures (excluding those few cases in which growth was stopped by blight before haulm destruction) are given in Table 4.

TABLE 4

MEAN EFFECT OF HAULM DESTRUCTION AT VARIOUS DATES ON TOTAL YIELD. KING EDWARD. WEST MIDLANDS, 1950–54

	Mid-August	End of August	Mid-September	End of September (Estimated Potential Yield)
Mean date of destruction (all trials) ..	Aug. 8	Sept. 1	Sept. 18	Sept. 30
Total yield, tons/acre	9·5	12·6	13·4	13·8
Percentage of potential yield	68	91	97	100
Provisional norm (for comparison) ..	62	88	97	100

The actual mean figures were again very close to those read off from the provisional normal curve, thus indicating that within practical limits the mean bulking curve derived from Majestic (Large, 1952) also proved valid for King Edward in the West Midlands over the years 1950–54.

In view of this and the other evidence obtained in these trials, it is fair to conclude that in those few districts and seasons when blight reaches the 75 per cent stage by the end of August in the West Midlands, the loss on the unsprayed King Edward will amount, on average, to some 9 to 13 per cent of the potential total yield. In the present trials most of this loss was recovered by protective spraying (where it was done efficiently) but it must be stressed that the work was done by hand, with a knapsack sprayer, and there was therefore no loss by wheel damage. In their trials on King Edward in the Wash Area, Large, Taylor, Storey and Yule (1954) showed that this loss from wheel damage in commercial spraying could amount to 4 per cent of the potential crop, even with a 13-row sprayer. This loss by wheel damage will reduce the gain from spraying in the "blight years", and it will also cause a positive loss, almost certainly exceeding the small gain from reduction of blight in the tubers, in the other years.

Further careful records of 75 per cent dates are needed to establish the true frequency of blight attacks justifying protective spraying in the West Midlands, but from the records so far available this may be only one year in two or three in Worcestershire and Shropshire, and perhaps less than one year in five over most of the rest of the province.

EFFECTS OF HAULM DESTRUCTION

Tables 2 and 4 show that although haulm destruction in early August reduced the mean weight of blighted tubers from about 13 to about 5 cwt per acre, this effect was obtained at the expense of the loss of about 4 tons per acre of the mean total crop, so that such very early haulm destruction is totally uneconomic.

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Haulm destruction at the end of August reduced the mean weight of blighted tubers from about 13 to about 8 cwt per acre at the expense of a mean loss of about 1 ton per acre of the total crop.

Haulm destruction in mid-September caused no significant reduction either in total yield, or in the weight of blighted tubers as compared with the results obtained when the haulm was not destroyed.

The results of the present trials support the view that haulm destruction is of much more value for clearing the ground before lifting than for blight control. The trials were on King Edward, which is more susceptible than Majestic to blight in the tubers, and the general level of blighted tubers (about 13 cwt per acre average for all the trials) was fairly high. An even higher level of tuber infection could, however, necessitate a re-appraisal of the desirability of haulm destruction at the end of August.

These trials were designed by Mr. N. C. Preston and Dr. H. E. Croxall in collaboration with Dr. D. A. Boyd of Rothamsted Experimental Station. The Provincial Field Experiments Committee proposed the problem and thanks are due to its Chairman, Dr. D. H. Robinson and all those officers of the N.A.A.S. who were responsible for the field work and exercised local supervision. The following farmers provided facilities for the work and I would like to thank them for their generous co-operation : Mr. J. V. Dakin, Mr. W. J. Ryman, Mr. R. S. Hodgetts, Apley Estates, Mr. K. Granger, S. Morton and Son, the late Col. H. B. Sankey, Mr. W. Goodier, Mr. T. Northcott, Mr. J. Nott, and Mr. A. Sethan.

REFERENCES

LARGE, E. C. (1952). The Interpretation of Progress Curves for Potato Blight and other Plant Diseases. *Plant Pathology*, **1**, 109–17.

LARGE, E. C., TAYLOR, R. ERIC, STOREY, I. F. and YULE, A. H. (1954). Spraying Trials in the Potato-growing Area around the Wash, 1948–53. *Plant Pathology*, **3**, 40–8.

LARGE, E. C. (1956). Potato Blight Forecasting and Survey Work in England and Wales, 1953–55. *Plant Pathology*, **5**, 39–52.

SMITH, L. P. (1956). Potato Blight Forecasting by 90 per cent Humidity Criteria. *Plant Pathology*, **5**, 83–7.

A CANKER DISEASE OF CHERRY TREES CAUSED BY VIRUS INFECTION

by A. F. POSNETTE and R. CROPLEY

East Malling Research Station, Kent

During a brief survey of sweet cherry orchards in the West Midlands to assess the prevalence of virus diseases, our attention was drawn to the severely cankered condition of trees in an orchard near Ledbury, Herefordshire. These trees, all of the variety Frogmore, had rough, fissured bark and their branches appeared to be knotted at most of the nodes ; many of their fruit spurs were dead. The distribution of the disease in the orchard suggested that it was not bacterial canker, *Pseudomonas mors-prunorum* Wormald, because varieties more susceptible than Frogmore to bacterial infection were unaffected. The absence of bacteria was later confirmed by Dr. J. E. Crosse (personal communication).

TRANSMISSION BY GRAFTING

Budwood, collected in July 1950, was used to inoculate the following trees at East Malling : two 3-year-old trees of Frogmore, and two 1-year-old trees of each of the varieties Mazzard 12/1, Early Rivers, Napoleon, Waterloo, Merton Heart and Merton Bigarreau ; an equal number of each variety were left unbudded as controls. The inoculated Frogmore trees developed necrotic spots on their leaves in 1951 and in successive years, but no symptoms were seen on the other varieties up to December 1954, when the Mazzard 12/1, Early Rivers, Napoleon and Waterloo trees were discarded. The Merton Heart and Merton Bigarreau trees were destroyed in December 1955 when the inoculated trees were noticeably smaller than the controls but otherwise symptomless.

Bark symptoms were first recorded on the inoculated Frogmore trees in the autumn of 1956 when there were well-developed cankers on the nodes of 2-year and older wood, dead spurs, and purplish-red sunken areas on the bark. Many of these sunken areas were split, exposing dead bark tissues.

A second transmission test was started in 1953 because it was thought that the then negative results from the previous test might have been due to the scions being free from a virus which was not fully systemic in the orchard trees. Fresh material was collected from the orchard, and three sets of five trees each were prepared by budding on F 12/1 stocks as follows :

1. Frogmore from cankered tree.
2. Normal Frogmore from East Malling source.
3. Normal Frogmore (as in 2) but with a bud from the canker source inserted about 2 inches below the normal bud on each stock ; these " infector " buds were not allowed to grow.

During the first year's growth the trees in sets 1 and 3 had drooping leaves with large necrotic spots (Plate III, 1), symptoms that were absent from the control trees in set 2. In the second year, trees in sets 1 and 3 again showed leaf symptoms and also premature defoliation in the autumn ; the stems were more flexible than those of the controls, and small splits developed, usually near a node. In the third year (1956), the leaf symptoms developed as in previous years and the splits developed into cankers by the death of the adjoining bark,

particularly around the spurs (Plate III, 2). Bud death was prevalent on the infected trees (sets 1 and 3), whereas only a few buds died on the control trees, and these, probably, as a result of bacterial infection.

SYMPTOMS ON FROGMORE CHERRY

The drooping aspect of the Frogmore leaves and the large necrotic spots, normally only two or three on each leaf and not accompanied by mottling, are not described symptoms of other virus diseases of cherry and there is no reason to doubt that they were caused by the canker virus. The size and colour of the necrotic areas, and their recurrence for four successive years on leaves formed both in spring and late summer, distinguish them from the leaf necrosis caused by numerous strains of necrotic ring spot virus (Posnette, 1954). Nearly all these strains were found to induce leaf symptoms on Mazzard F 12/1, but trees of this clone were unaffected by inoculation with buds from a cankered Frogmore tree. Affected Frogmore trees have shed their leaves each autumn several weeks before healthy trees ; no mottling of senescent leaves has been recorded.

Lesions on the bark develop first around buds ; necrosis of isolated cells and groups of cells in the cortex can be seen microscopically before external symptoms are obvious. Necrotic areas are bounded internally by a secondary phellogen ; in some sections, however, the phellogen appears to have cut off tissues with no obvious signs of necrosis (Plate II, 1). The lesions extend radially in the cortex, and they also increase in area, mainly longitudinally above and below the bud. There is no gum exudation or formation of blisters, and the dead areas of bark become sunken and later split (Plate III, 4). As the necrosis progresses between the nodes, the surface of the 3-year and older branches becomes rough with deep fissures and scaling bark (Plate III, 3). At this stage most of the buds and fruit spurs are dead.

Young shoots of affected Frogmore trees were found to differ in winter from those of normal trees in the following characteristic distinguishing this disease from bacterial canker. When the leaf scars and subtended buds were sliced off shoots that had been formed in the previous summer, the vascular traces were found to be stained brown below almost all the leaf scars, but no brown traces were found on shoots from normal trees. In microscope sections the browning was seen to be due to gum filling many of the xylem vessels (Plate II, 2). This condition may account for the drooping habit and early shedding of leaves on infected trees. In bacterial infection, only a small proportion of leaf scars would be expected to show browning of the traces, and this is associated with necrosis of phloem tissues (Crosse, 1956).

DISCUSSION

This canker disease has reduced the growth of Frogmore cherry trees and must be expected to have an even more serious effect on cropping because a high proportion of fruit spurs are killed. Field observations suggest that this disease may be the cause of decline in trees of other varieties, particularly Noble, in which the profusion of dead spurs appears to be a useful aid in identifying the variety. One unusual feature is the tolerance of the Mazzard F 12/1 clone to the virus. F 12/1 is so sensitive to most other cherry viruses that it is a useful indicator plant (Posnette and Cropley, 1956), and this character renders nursery inspection and certification of F 12/1 rootstocks a valuable means of ensuring that nurserymen use healthy rootstocks for raising commercial cherry trees. Infection with canker virus, however, would not be detected by inspection and the use of indexed material is the only safeguard.

Other virus-induced canker diseases of cherry have been described in North America. Black Canker disease in Oregon (Zeller, Kienholz and Milbrath, 1951) induces cankers on Napoleon similar to those on Frogmore trees in England, but the leaf symptoms caused by the Frogmore canker virus and its failure to induce symptoms on Napoleon during four years following inoculation are distinguishing features.

Bark Blister (Stout, 1949), Necrotic Rusty Mottle and Dixie Rusty Mottle all cause necrotic leaf spots and bark lesions (Richards and Cochran, 1956), but the accompanying leaf mottle and the " blister-like " bark lesions are not symptoms of infection with the Frogmore canker virus. Furthermore, F 12/1 plants are very sensitive to English strains of the rusty mottle and leaf roll viruses (Posnette and Cropley, 1955), and these may have affinities with necrotic rusty mottle virus. This variety, however, is highly tolerant of the canker virus.

The symptoms distinguishing these American diseases from the one in England may be due to differing varietal reactions, and this is being checked in experiments with the varieties Bing, Lambert and Napoleon. Until the reaction of these varieties to the virus from Frogmore has been investigated it seems preferable to call the English disease the " Frogmore Virus Canker ", rather than to invent a name which would imply an established distinction between it and other virus-induced canker diseases of cherry.

SUMMARY

A disease causing rough bark, spur cankers and bud death on Frogmore sweet cherry trees has been shown to be graft-transmissible. Superficially, the symptoms resemble those of bacterial canker in both leaf spot and canker stages, but the process of bark necrosis, the absence of pathogenic organisms, the perpetuation and transmission by grafting distinguish the virus from the bacterial disease.

The differences between the canker virus disease and others described in North America may be due to varietal differences only, and so the name " Frogmore Virus Canker " is suggested to refer to this disease until more is known about its relationship to other virus diseases.

We are indebted to Dr. Barbara Mosse for the preparation of microscope sections and for advice on the histology of diseased cherry bark. The photographs were taken by Mr. E. Yoxall Jones.

REFERENCES

CROSSE, J. E. (1956). Bacterial Canker of Stone-fruits. II. Leaf Scar Infection of Cherry. *J. hort. Sci.*, **31**, 212–24.

POSNETTE, A. F. (1954). Virus Diseases of Cherry Trees in England. I. Survey of Diseases Present. *J. hort. Sci.*, **29**, 44–58.

POSNETTE, A. F. and CROPLEY, R. (1955). Leaf Roll : a Virus Disease of Cherry. *Rep. E. Malling Res. Sta.*, 1954, 126–7.

POSNETTE, A. F. and CROPLEY, R. (1956). Virus Diseases of Cherry Trees in England. II. Growth Suppression caused by some Viruses. *J. hort. Sci.*, **31**, 298–302.

RICHARDS, B. L. and COCHRAN, L. C. (1956). Virus and Virus-like Diseases of Stone Fruits in Utah. *Bull. Utah agric. Coll.*, No. 384, 65–73.

STOUT, G. L. (1949). Cherry Bark Blister. *Bull. Calif. Dep. Agric.*, **38**, 257–60.

ZELLER, S. M., KIENHOLZ, J. R. and MILBRATH, J. A. (1951). Black Canker. (*In :* Virus Diseases and other Disorders with Viruslike Symptoms of Stone Fruits in North America.) *U.S.D.A. Agriculture Handbook*, No. 10, 137–8.

OBSERVATIONS ON THE CONTROL OF AMERICAN GOOSEBERRY MILDEW

by R. ERIC TAYLOR* AND ELIZABETH R. SCHOFIELD

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Pilot observations and replicated trials on the control of American Gooseberry Mildew, *Sphaerotheca mors-uvae* (Scher.) Berk., by spraying, were carried out on commercial plantations in Worcestershire over the years 1954–56. The degree of replication, layout, and introduction of unsprayed control plots were necessarily determined by economic considerations.

In 1954, at Fladbury, a comparison was made of the relative control of the disease effected by wet sprays containing washing soda/soft soap, dinitrocaprylphenyl crotonate, zineb, ziram, ferbam, and manganese dimethyldithiocarbamate. The variety Leveller was used in this experiment. The treatments were made in duplicate only, and the one application given was when the berries were about quarter grown. With washing soda/soft soap and with dinitrocaprylphenyl crotonate, the level of infection before harvesting, based on the percentage of mildewed fruits, was slight and very slight respectively, but substantial infection was observed in one or other plot with each of the other treatments. A marginal scorch of the leaves followed the use of washing soda/soft soap, but no damage on this sulphur-shy variety resulted from the use of the other materials. The degree of replication was insufficient for satisfactory statistical analysis, but the two most promising treatments were included in replicated trials in 1955 and 1956.

In 1955, on a plantation of Careless at Pershore, further pilot observations were made on single strips, each four rows wide and 132 bushes in length. Each strip was sprayed once, when the fruit had set, with one of five treatments. Assessments were based on the number of infected berries in samples of fifty. Sets of five samples, one from each treatment, were taken across the plots at thirty positions down the field. Infection was slight in the dinitrocaprylphenyl crotonate strip, but heavily-infected bushes were found in each of the other treatments. The number of berries infected in the total of 30 samples from each treatment were: dinitrocaprylphenyl crotonate (32); washing soda/soft soap (77); 1 per cent lime sulphur (92); manganese dimethyldithiocarbamate (181) and a white-oil preparation (183). These assessments, based solely on sampling intensity without replication, made statistical analysis impossible. The results, however, again indicated the effectiveness of both washing soda/soft soap and dinitrocaprylphenyl crotonate in controlling American Gooseberry Mildew.

SPRAYING TRIALS 1955–56

Two replicated trials were laid down, one in 1955, at Fladbury, in which dinitrocaprylphenyl crotonate, washing soda/soft soap and manganese dimethyldithiocarbamate were compared, and a second at Birlingham, in 1956, in

* Now at Trawscoed, Aberystwyth.

which a further treatment, washing soda/wetter, and unsprayed controls were included. The gooseberries at each site were underplanted in plum orchards and were reported to have been attacked by mildew consistently for a number of years.

The treatments included in the trials, and the materials and strengths at which they were used were:

A. Dinitrocaprylphenyl crotonate: 1 lb of a 25 per cent wettable powder and 6 fl.oz of a proprietary wetting agent (containing 21 per cent of a sodium secondary alkyl sulphate) in 100 gal water.

B. Washing soda 20 lb and soft soap 10 lb in 100 gal water.

C. Washing soda 20 lb and 6 fl.oz of a proprietary wetting agent (containing 21 per cent of a sodium secondary alkyl sulphate) in 100 gal water.

D. A proprietary product containing 42·5 per cent manganese dimethyldithiocarbamate: 1¼ pt. in 100 gal water.

E. Unsprayed.

The 1955 trial, on the variety Leveller, consisted of four replications of three randomized treatments, A, B, and D, giving a total of twelve plots. The plots were arranged so that each comprised three bays between plum rows. Discounting bushes actually in the plum rows, each bay contained four rows of bushes, and each plot approximately 140 bushes. Between plots, one row of bushes in a plum row was left unsprayed. The sprays were applied on May 19, when the fruit had just set, and again on June 10, at the rate of 25 gallons per plot, using a hand lance operated from a power sprayer. Mildew was not observed until June 6 when infection throughout the experimental area was very slight. Assessments of mildew on the berries were made on July 13–14. From each of four bushes, selected at random in the centre four rows of each plot, five separate samples of fifty berries were examined and mildewed berries recorded. A total of 1,000 berries were thus examined in each plot. The results are summarized in Table 1.

TABLE 1

NUMBER OF MILDEWED BERRIES IN EACH PLOT, 1955

(based on 1,000-berry counts)

Treatment	I	II	III	IV	Total	Infection *per cent**
A. Dinitrocaprylphenyl crotonate + wetter	2	11	1	1	15	0·3
B. Washing soda/soft soap	67	40	3	6	116	2·2
D. Manganese dimethyldithiocarbamate	56	78	236	21	391	8·4

* After angular transformation of the figures for analysis.

The 1956 trial, on the variety Keepsake, consisted of five replications of four treatments, A, B, C and E, including unsprayed controls, giving a total of twenty plots. Each plot contained 5–6 bushes of variable size, and sprays were applied with a knapsack sprayer at the rate of 6–8 gal per 28 bushes. The whole area had been sprayed with washing soda and wetter by the grower on April 9 just before flowering, and the experimental sprays were applied on May 3 and 26. Mildew assessments were made on July 2, by recording the number of mildewed berries in two 50-berry samples from each of five bushes in each plot. The results are given in Table 2.

TABLE 2

NUMBER OF MILDEWED BERRIES IN EIGHT SAMPLES COMPRISING 500 BERRIES IN EACH PLOT, 1956

Treatment	I	II	III	IV	V	Total	Infection *per cent**
A. Dinitrocaprylphenyl crotonate + wetter	0	1	0	0	0	1	0·0
B. Washing soda/soft soap ..	6	8	9	1	2	26	1·0
C. Washing soda/wetter ..	6	19	5	1	2	33	1·3
E. Unsprayed	7	5	47	4	0	63	1·6

* After angular transformation of the figures for analysis.

In the 1955 trial, dinitrocaprylphenyl crotonate was, at the 5 per cent level, significantly more effective in controlling American Gooseberry Mildew than manganese dimethyldithiocarbamate. The level of infection was less in 1956, but control with dinitrocaprylphenyl crotonate was virtually complete; there was, at the 1 per cent level, significantly less infection than with washing soda/soft soap, washing soda/wetter, or unsprayed controls. There was no significance in 1955 between dinitrocaprylphenyl crotonate and washing soda/soft soap, or between washing soda/soft soap and manganese dimethyldithiocarbamate, and in 1956, washing soda/soft soap, washing soda/wetter, and unsprayed controls did not differ significantly. No spray damage was observed in either trial.

We thank Mr. C. H. Crowther of Messrs. Ross Bros., Mr. G. Francis, Mr. T. Bomford and Mr. J. Holding for providing facilities for trials and observation studies on their land; Mr. G. M. Clarke of Long Ashton Research Station for statistical advice; Mr. J. L. Beddall, Mr. W. E. Roberts and Mr. N. Jacob for assistance in the field work; and commercial firms for the supply of materials.

ONE-YEAR LEYS ON CLOVER-SICK LAND

by HOWARD MEAD

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The industrial area of north-east England is to a large extent arable, and the production of cash crops is an important source of farm income. The one-year ley, which is normally cut for hay, is part of a very limited four-course rotation. For some time it has been known that there is a certain amount of clover sickness and clover rot in the area of the Northumberland and Durham coalfield. Advisory visits to holdings where the farmers were puzzled by " white hay " (hay without legumes) suggested that the main cause of low clover survival was *Ditylenchus dipsaci* (Kühn), the Stem and Bulb eelworm.

Little was known about the legumes which could be recommended to farmers to replace broad and late-flowering red clovers on sick land, and it was decided that some pilot field trials should be put in hand using legumes that Goodey

(*Plant Parasitic Nematodes*, Methuen, London, 1933) considered eelworm resistant. The seed mixtures finally prepared were as follows:

Species in Mixture	Lb of Seed per Acre				
Italian ryegrass	10	10	10	10	10
Perennial ryegrass	10	10	10	10	10
Broad red clover	5	—	—	—	—
S123 extra late-flowering red clover	—	5	—	—	3
Alsike	—	—	—	4	—
New Zealand certified mother seed white clover	—	—	3	—	1
Total lb per acre	25	25	23	24	24
Cost of clovers per acre (1954)	15*s.*	40*s.*	24*s.*	14*s.*	32*s.*

All clover seed was treated with a 0·025 per cent solution of iodine in water before sowing, to kill any eelworm larvae that might have been present on the testae. Three replicates of each of the five seed mixtures were drilled as $\frac{1}{8}$-acre plots on a field known to have a high incidence of eelworm, and a further two replicates of each treatment were drilled, also as $\frac{1}{8}$-acre plots, on a field which had no history of clover trouble and which was some distance from the general area in which the pest is troublesome. It should be noted that the quantities of grasses remained constant in the five mixtures, and that in both fields the plots were undersown in oats.

Immediately before the farmers started their haymaking, 20 cuts of one square yard each were taken at random on each plot and weighed. The bulk in each instance was then sampled for dry matter and crude protein analysis, and the results are shown in the table below:

Seed Mixture	Cwt per Acre of Dry Matter and Crude Protein			
	Infested Field		Uninfested Field	
	Mean Dry Matter	Mean Crude Protein	Dry Matter	Protein
Broad red	12·0	1·2	36·1	2·3
S. 123	24·1	3·5	30·5	1·5
New Zealand white	25·0	3·0	32·8	2·0
Alsike	23·3	3·5	33·3	1·8
New Zealand white plus S.123	23·9	3·4	34·3	2·0
S.E.	±2·2	±0·4	±2·3	±0·2

On the infested site the broad red mixture yielded significantly less dry matter ($P = 0·05$) and crude protein ($P = 0·01$) than any of the other mixtures. It appears therefore that Alsike and the big-leaved white clover can contribute substantially to hay yields on infested land. Yields from the broad red plots at the infested site consisted entirely of the two grass species. At this site the clover germinated well and established itself satisfactorily but samples examined in the laboratory after harvesting the cover crop showed severe eelworm invasion. By the following spring nearly all the clover plants were brown and shrivelled and they died out completely shortly afterwards.

SCORCH OF WINTER CAULIFLOWER

by J. G. JENKINSON

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AND W. CAMPBELL

National Agricultural Advisory Service, Starcross, Exeter

A condition of winter cauliflower known as " scorch " has been common for many years in the South-West, and has been responsible for considerable losses of crop. The heart leaves of affected plants do not develop normally, but become stunted and brown at the tips (Plate I). Secondary bacterial rotting of these leaves is often eventually responsible for the death of the plant. All our attempts to isolate parasitic bacteria or fungi from affected plants have failed, and we have also been unsuccessful in demonstrating that the condition was due to virus infection. The symptoms suggest that the cause might be a mineral deficiency, but as the affected plants are randomly scattered in winter cauliflower crops this is unlikely to be the full explanation of the condition. This paper supplies some evidence that scorch is inherited, and that the incidence of scorch varies considerably in different varieties. The incidence of scorch in any one variety has been shown to be affected by the level of manuring with inorganic nitrogen.

SYMPTOMS

Symptoms normally develop about two to three months after planting. Growth of cells in the region of the main vein at the tip of the young leaves is checked and these cells finally die. The area of dead cells gradually extends backwards, the rate being dependent on the weather and the extent of contamination with bacteria. It is most rapid under mild humid conditions ; in dry weather comparatively little necrosis occurs, sometimes the only symptoms being that the shape of the leaf tip is altered. Symptoms normally reach their maximum at the time of heading, when the heart leaves in severely affected plants may be killed outright. The curds in such plants are reduced in size and usually show bacterial rotting. Scorched plants are extremely susceptible to frosting, partly because of the abnormal cell development at the leaf tips, and partly because the young leaves do not cover the developing curds to the same extent as in healthy plants.

Susceptibility to scorch also appears to be correlated with the rate of growth, and is greatest when the leaves are expanding rapidly. Occasionally a plant shows scorching only on the middle-aged leaves which expand when the rate of growth of that particular plant is at its maximum.

INCIDENCE OF SCORCH IN WINTER CAULIFLOWER VARIETIES

Recordings were made of a series of three winter cauliflower variety trials for the incidence of scorch using the following 0–3 scale :

0 No symptoms.
1 Slight scorching of young leaves.
2 Moderate scorching of young leaves and some scorching apparent on the older leaves.
3 Severe scorching of the young leaves, the whole plant being affected and stunted.

Scorch of Winter Cauliflower

Each plot contained sixty plants of one variety, and there were at least five replications of each variety. The incidence of scorch is given as the mean scorch score per plant of each variety. Each trial was recorded a week before cutting started, and the results obtained are given in the table below.

Mean Scorch Score per Plant: Winter Cauliflower Varieties

	Period of Heading	Variety	Mean Scorch Score per Plant	Sig. Dif. Between Means (P = 0·05)
Extra Early Roscoff broccoli ..	December–January 1955–56	A	0·237	
		B	0·310	
		C	0·227	
		D	0·597	0·123
Late Autumn cauliflower	December–January 1955–56	E	0·751	
		F	0·391	
		G	0·220	
		H	0·713	
		I	0·655	
		J	1·013	
		K	0·480	0·211
No. 1 Roscoff broccoli	January 1956	L	0·283	
		M	0·617	
		N	0·217	
		O	0·200	0·138

In each trial, significant differences were obtained between the varieties showing the least and the greatest amount of scorch. This suggests that susceptibility to scorch is an inherited characteristic. To confirm this, six scorched plants were selected and selfed and 50 plants from each of their progenies were scored for scorch in the same way as the variety trials. As severe scorching results in the death of the plants it was only possible to use as parents plants which were slightly affected. Fifty plants of a variety which headed at the same time and which had not shown any appreciable scorching in trials were included as a control plot in 1955. The results were as follows :

Progeny	1	2	3	4	5	6	Control
Mean scorch score per plant ..	0·6	0·7	1·1	2·2	2·7	2·8	0·1

As the number of plants of each progeny was limited it was impossible to replicate the plots sufficiently to enable a statistical analysis to be carried out, but the high scores exhibited by certain progenies compared with the control supply confirmation of the fact that the condition is inherited.

Effect of Nitrogen Manuring on the Incidence of Scorch

As the incidence of scorch in field crops appeared to be highest under conditions of heavy nitrogen manuring, a manurial trial of Extra Early Roscoff broccoli at Rosewarne Experimental Horticulture Station in 1955–56 was scored for scorch. Some of the trial plots of eighty plants had received varying quantities of inorganic nitrogen (as sulphate of ammonia), each manurial treatment being replicated four times. The recordings on these plots were as follows :

Nitrogen *cwt per acre*	Mean Scorch Score per Plant	Sig. Dif. Between Means (P=0·05)
0	0·281	
0·6	0·367	
1·2	0·484	
1·8	0·603	0·214

Scoring of other plots in the same trial showed that the addition of six tons dry weight per acre of either dung, compost or seaweed had no significant effect on the incidence of scorch, but that the addition of 0·6 cwt of nitrogen to plots which had already received organic manures increased the mean scorch score per plant from 0·31 to 0·48, and this difference was significant at the 5 per cent probability level.

A further trial was carried out in which the progeny from a single selfed B1 Roscoff broccoli which had shown scorch symptons in the previous year, was planted out in four plots of ninety plants each. The fertilizer treatment applied to each plot and the results of the scoring were :

Fertilizer Treatment *per acre*	Mean Scorch Score per Plant	Plants Finally Killed by Scorch *per cent*
5 tons F.Y.M. (dry weight) plus 5 cwt N (as sulphate of ammonia)	2·01	50·0
5 cwt N (as sulphate of ammonia)	1·80	38·0
5 tons F.Y.M. (dry weight)	0·52	7·7
None	0·53	6·6

The effect of inorganic nitrogen on the incidence of scorch was again considerable, whereas the application of organic manure had no significant effect.

DISCUSSION

The results obtained from the observations and experiments described show that leaf scorch is an inherited character, the expression of which in the field is influenced by the level of inorganic nitrogen manuring. The considerable variation in the degree of scorch found in plants grown at the same manurial level suggests that a number of genes may be involved, and work is now in progress to obtain further information on this point. No information has been obtained so far as to the actual cause of the breakdown, although the symptoms suggest that it may be due to a deficiency of some particular mineral which is required in varying amounts by individual plants, those which are the most severely scorched having the greatest requirement. This hypothesis would account for the distribution of the affected plants in the field, and also for the effect of inorganic nitrogen as rapidly developing plants are likely to require greater amounts of all minerals than plants which are developing slowly. However, it does not account for the fact that scorched plants have been found on many different soils. The only mineral so far tested by the authors has been boron, which had no effect on the incidence of scorch.

The only practical control measure available so far is the careful selection of plants which show no scorch symptoms for mother seed. A more stringent test which would be preferable where it is practicable would be to self the selected mother plants, and to use only those families which were free from scorch when grown with heavy inorganic nitrogen manuring for mother seed production.

We wish to acknowledge the co-operation of Mr. F. W. Shepherd, Director of Rosewarne Experimental Horticulture Station, Camborne, and the help given in various ways by Mr. K. E. Haine (Seale-Hayne), Mr. P. D. Wood (Rosewarne) and Mr. R. Hawken (N.A.A.S., Starcross).

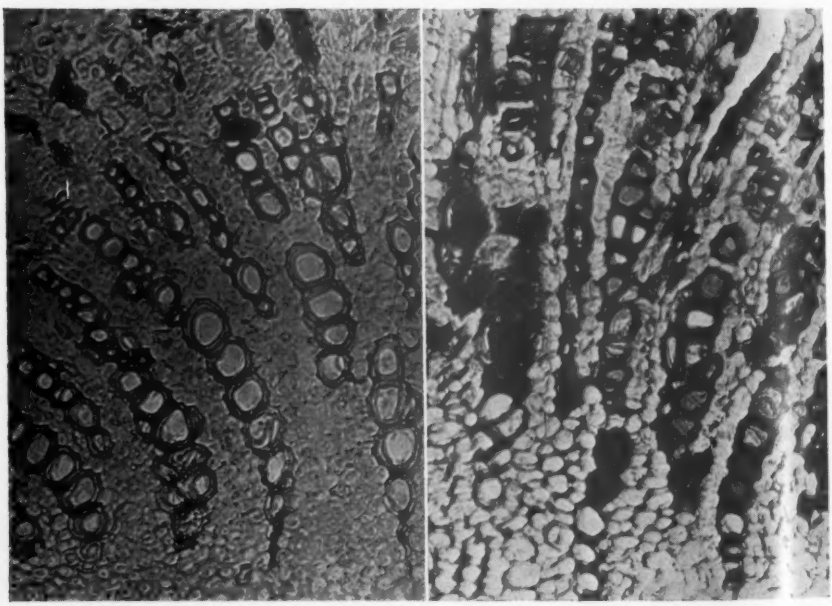
We thank Mr. H. C. Woodville (N.A.A.S., Starcross) for the photographs.

Roscoff B1 showing severe scorch and browning at tips of heart leaves.

PLATE I

[7011

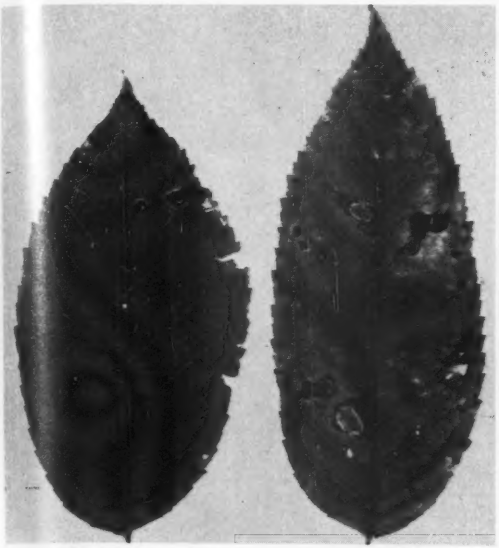
1. Transverse section of bark showing the secondary phellogen in the first stage of canker formation.



Photos : East Malling Research Station

2. Section through leaf-trace, (*left*) on a healthy stem, and (*right*) on an infected stem, showing gum-filled vessels and necrosis.

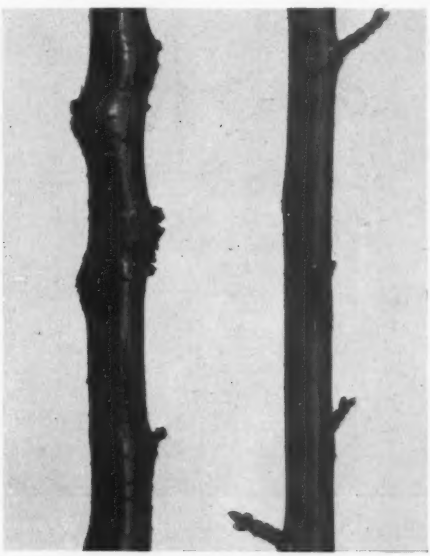
PLATE II



1. Leaf spot symptoms.

2. Early stage of canker around bud on one-year-old stem.

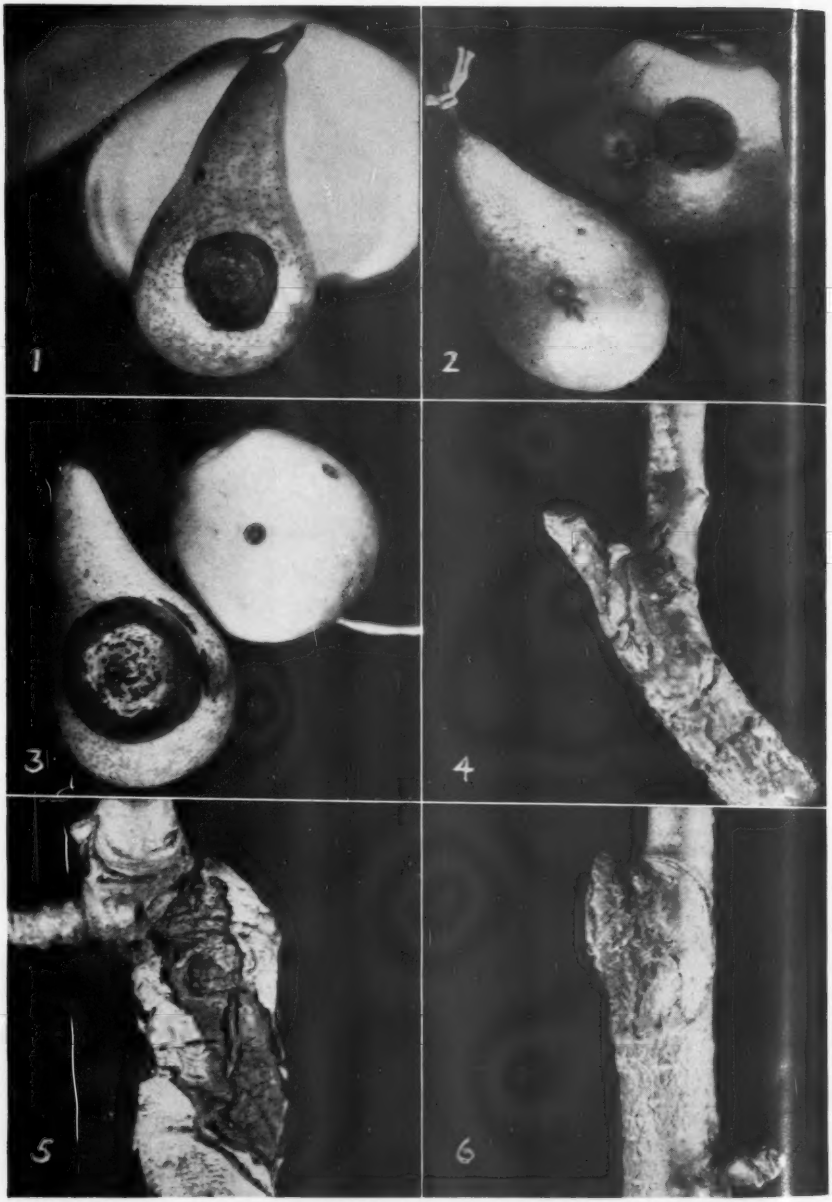
3. Rough bark and dead branches on five-year-old stem.



Photos : East Malling Research Station

4. *Left :* Dead spurs and cankers on three-year-old stem of Frogmore cherry. *Right :* Healthy stem.

PLATE III



Photos : Murphy Chemical Co. Ltd.

1. Natural infection of *Gloeosporium perennans* on pear.
2. Apple naturally infected with pear inoculated from it.
3. Pear naturally infected with apple inoculated from it.
4, 5, 6. Pear wood cankers from which *G. perennans* was isolated.

PLATE IV

PERENNIAL CANKER OF PEAR

by R. W. GROOM AND J. C. HALL

The Murphy Chemical Company Ltd., Wheathampstead, Herts

During a survey of the distribution and incidence of Gloeosporium infection of stored apples and pears in this country, we received samples of Conference pear fruit bearing characteristic Gloeosporium lesions. Such infected fruit was received from three orchards in Essex, and one each in Worcestershire and in the Wisbech area of Cambridgeshire.

These lesions (Plate IV, 1) were found to be due to *Gloeosporium perennans* Zeller & Childs. The identity and pathogenicity of the fungus was confirmed by cross inoculations between infected pears and clean Cox's Orange Pippin apples, and between Cox's Orange Pippin apples and clean pears, using wound inoculation and dipping in spore suspensions. In all cases typical Gloeosporium lesions were produced (Plate IV, 2 and 3).

It is significant to note from this work that *G. perennans* showed no specificity between apple and pear fruits. Some of the pear fruits received were found to be infected by *G. perennans* and *G. album* together. Apples have also been found infected in a similar manner.

Cankers similar to those associated with perennial canker of apples were also present on the trees in the pear orchards concerned. Despite prolonged incubation and exacting microscopical examination, we found only one case, in Essex, where the wood of these trees showed infection—in the callus tissue of a pruning cut (Plate IV, 4). It was also isolated, however, from wood of a pear orchard in Kent, where fruit was unobtainable. Here it was found in the bark of a branch canker associated with *Phacidiella discolor* (Mouton & Sacc.) Potebn. (Plate IV, 5), and again in diseased tissue about a pruning cut (Plate IV, 6). Similarly, Kienholz, who has noted the occurrence of the disease on pears in the U.S.A. (*J. agric. Res.*, 1939, **59**, 635–65) has informed us that he has found acervuli on small dead flakes of bark surrounding callus tissue on pruning cuts. He has also found the fungus on old dead bark. From the apparent rarity of acervuli, it would appear that *G. perennans* may be superficial on pear twigs and branches, occurring only as a saprophyte or weak parasite. Wood from many other pear varieties, and from a number of different counties, was also examined, but with a negative result.

Although *G. album* Osterw. and *G. fructigenum* Berk. are known to infect pears (Kidd, M. N. and Beaumont, A., *Trans. Brit. mycol. Soc.*, 1924, **10**, 98 ; Grove, W. B., *British Stem and Leaf Fungi*, 1937, **II**, 221), we believe that this is the first record of *Gloeosporium perennans* on pear fruit and wood in this country.

CONTROL OF SOME BEAN AND POTATO PESTS USING A SYSTEMIC INSECTICIDE APPLIED TO THE SOIL AND SEED

by M. J. WAY AND P. H. NEEDHAM

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A systemic insecticide used as a seed dressing or drilled with the seed can subsequently kill insects attacking the aerial parts of the plant (Andersson and Ossiannilsson, 1951 ; Ashdown and Cordner, 1952 ; Unterstenhöfer, 1953). This paper gives results of field experiments with the systemic insecticide demeton applied at sowing time for control of the Black Bean aphid *Aphis fabae* Scop., the Vetch aphid *Megoura viciae* Buckt., the Green Peach aphid *Myzus persicae* Sulz. on potatoes and the Pea and Bean weevil *Sitona lineatus* L. on field beans.

MATERIALS AND METHODS

The demeton used in most experiments was a purified preparation supplied by the manufacturers, being a mixture of the two isomers, diethyl 2-ethylethioethyl phosphorothionate and diethyl S-(2-ethylethioethyl) phosphorothiolate. With powdered activated charcoal as diluent, 30 per cent demeton made a free-flowing dust, and 45 per cent demeton a sticky powder suitable for seed dressing. A 50 per cent dust with activated charcoal, supplied by the manufacturers, was used in some experiments. Emulsions in water for spraying and seed soaking were made by mixing the demeton with an equal volume of a proprietary emulsifier (Lissapol N). The dust was diluted with about five times its volume of dry sand just before it was applied (Ashdown and Cordner, 1952). This helped to get it evenly distributed.

A spring-sown tick was used for all bean experiments. Its average seed weight was 0·46 grammes—about one quarter of the weight of a broad bean seed. Seed-size tubers of the potato, variety King Edward, were used.

Most trials were laid down as randomized blocks of micro-plots with each treatment replicated on four plots. Each plot usually comprised four 4-foot rows of beans or three 4-foot rows of potatoes (one plant per foot of row). Beans, sown at eight per foot, were thinned to four per foot to ensure similar plant populations despite possible differences in germination.

In experiments with *A. fabae* and *S. lineatus*, naturally occurring populations were used to determine the effect of the treatments. *A. fabae* numbers were estimated by a method of categorization (Way, Smith and Potter, 1954). *S. lineatus* adults were difficult to count because they fell from the plant when disturbed. The effect of a treatment was therefore determined indirectly by counting the characteristic feeding notches on all plants in the centre two rows of each plot.

M. persicae was uncommon on potatoes and therefore colonies were established artificially at intervals during the growing season. A known number (usually 5 or 10) of laboratory-reared young adult apterae were caged in an

organdie sleeve on the top 3–4 inches of the potato stem, using 5–12 sleeves per treatment. The sleeves did not enhance a fumigant effect, for experiments showed that demeton absorbed from soil was not transpired from the leaves fast enough to act as a fumigant (cf., David, 1957). After one week the living and dead adult *M. persicae* and their progeny were counted. The effect of a treatment could be gauged from the mortality of the introduced adults and from the numbers of live progeny produced in each treatment. The usual procedure, however, was to count the total living aphids in each treatment after one week, and express them as percentages of the number on the untreated plots. Data from one experiment are given in Table 1 to show the sensitivity of the method.

TABLE 1

THE EFFECT OF CAGING ADULT M. PERSICAE FOR ONE WEEK ON 11-WEEK OLD POTATO PLANTS TREATED WITH DEMETON WHEN PLANTED

Demeton *g per plant*	Kill of Adult *M. persicae per cent*	Live Nymphs per Adult	Total Living Aphids (Percentage of Number on Untreated Plants)
0	12	15	100
0·125	47	9	65
0·25	71	3	38
0·5	84	1	16
1·0	99	0·03	0·3

The sleeve method was used in some experiments with *M. viciae* on beans. This aphid, unlike *A. fabae*, thrives in the sleeve cages and can also be handled much more easily.

PHYTOTOXICITY TESTS WITH BEAN SEED

Treated seeds were germinated in John Innes potting soil at a constant temperature of 20° C. A seed dressing with as much 45 per cent demeton dust as would adhere (0·026 grammes demeton per seed) did not stop germination nor did a soil treatment of 2·5 grammes of 30 per cent demeton per foot of seed drill.

Batches of 100 seeds were immersed for four hours at 20° C in emulsions containing 0, 0·5, 1, 2 and 4 per cent w/v demeton. The percentages of seeds germinating after planting in soil were 100, 93, 86, 84 and 74 respectively. The tick bean seed appears to be more resistant then broad bean seed of which only two out of ten developed after being soaked for four hours in 1 per cent demeton emulsion (David and Gardiner, 1955).

Details of treatments for the field experiments were as follows : seed soaking—soaked four hours in 2 per cent demeton in water (assuming that the demeton was absorbed in proportion to its concentration in the emulsion (David and Gardiner, 1955) the dose was 0·0031 grammes demeton per seed) ; seed dressing —0·012 grammes demeton per seed ; soil treatment—0·18 grammes demeton per plant.

These treatments give three levels of dose. It is noteworthy, however, that the lowest, obtained by immersing the seed in a demeton emulsion, was the only one which affected germination. This was confirmed by plant counts in two field experiments which are given in Table 2.

A slight peripheral scorch developed on the first leaves of some plants in the soil- and seed-dressed treatments at Woburn Stackyard and in the soil treatment at Rothamsted ; also, the primary root of some plants was destroyed or

distorted. This delayed development but recovery was rapid after adventitious roots had formed. Such damage was not seen on seed-soaked plants which, if they germinated, developed normally.

TABLE 2

GERMINATION COUNTS IN PHYTOTOXICITY TESTS ON BEAN SEED

Treatment	Demeton per Seed *grammes*	Seeds Germinating—Percentage of Number Sown	
		Rothamsted	Woburn Stackyard
Soil-treated	0·18	97	89
Seed-dressed	0·012	94	94
Seed-soaked	0·0031	66	80
Untreated	0	94	93

CONTROL OF SITONA LINEATUS ON SPRING BEANS

Adult *S. lineatus* started feeding by the beginning of May 1953 and continued until after the end of the month. Table 3 shows the counts of feeding notches made on three randomized block experiments with beans sown on March 10, 1953. The doses of insecticide are as shown in Table 2.

TABLE 3

EFFECT OF DEMETON TREATMENTS ON S. LINEATUS

Experiment	Date	Average Number of *S. lineatus* Feeding Notches per Plant			
		Soil-treated	Seed-dressed	Seed-soaked	Untreated
Woburn (Warren Field)	4.5.53	2	4	22	58
	13.5.53	5	10	71	105
	22.5.53	9	25	119	143
Woburn (Stackyard) ..	13.5.53	5	6	52	80
Rothamsted	13.5.53	1	4	13	34

At Woburn Warren Field, where the attack was heaviest, damage on May 4, 55 days after sowing, was much less on treated than on the untreated plots, but by May 22 only the seed-dressed and soil treatments were giving good protection. Dead and dying weevils were found and it was confirmed in laboratory experiments that they died after eating foliage of seed-dressed plants. It should be mentioned that micro-plot experiments are unsuitable for studying insect species such as *S. lineatus* which can move easily from plot to plot. Hence, in practice, control of *S. lineatus* would probably be better than the results suggest.

Experiments using demeton for control of *S. lineatus* adults on peas have been reported (Needham and Way, 1955). A seed dressing of 0·00015 grammes demeton per seed had no effect, but a soil treatment, equivalent to 0·0017 grammes per seed, gave good protection.

CONTROL OF APHIS FABAE ON SPRING BEANS

Damage by *A. fabae* is caused mostly by the apterous progeny of alate primary migrants and is largely prevented if the primary migrants are killed when they arrive in the crop in June (Way *et al.*, 1954). A systemic insecticide applied as a seed dressing at sowing time (February to April) would therefore need to persist in the stem for about 2–4 months to control *A. fabae*.

Results of experiments at Rothamsted and Woburn Stackyard with beans sown on March 10, 1953 are given in Fig. 1 and Table 4.

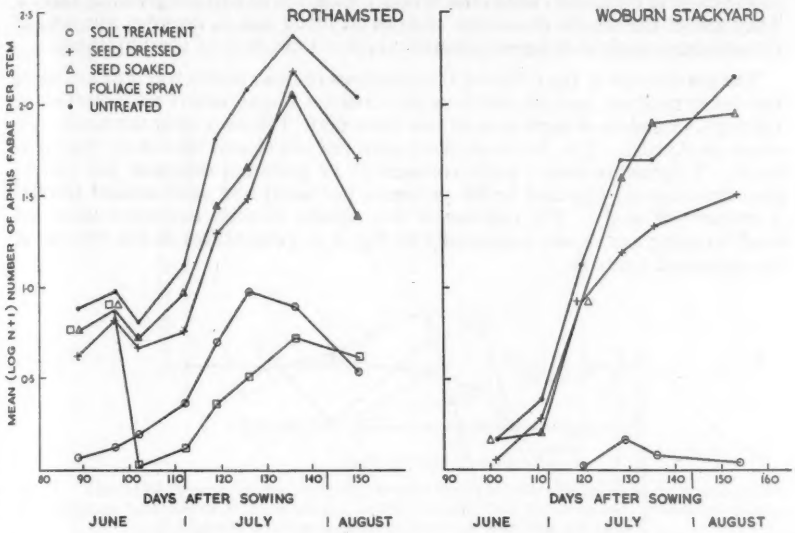

Fig. 1. Mean (log $n + 1$) numbers of aphids per stem counted at intervals during two experiments on seed and soil treatment with demeton for control of *A. fabae*. *Left*, at Rothamsted, *right*, at Woburn Stackyard.

Their similarity indicates that the soil type—clay at Rothamsted and sandy at Woburn—was not an important factor. The Rothamsted experiment included a conventional foliage-spray treatment of 0·025 per cent demeton emulsion in water applied by hand sprayer at approximately 80 gallons per acre on June 18. Table 4 shows that this and the soil treatments gave 94–99 per cent control of *A. fabae*. The other treatments were relatively ineffective, although all except the seed-soaked treatment of the Woburn experiment reduced the aphid population significantly.

In the foliage spray treatment, not all the insecticide hit the plants, but, assuming it did, the dose of demeton was about 0·001 grammes per plant. This contrasts with 0·18 grammes per plant needed for similar control by soil treatment.

TABLE 4

RESULTS OF SEED AND SOIL TREATMENTS WITH DEMETON FOR CONTROL OF *A. FABAE* ON FIELD BEANS

Treatment	Demeton per Plant *grammes*	Mean (log $n + 1$) Aphids per Stem between Mid-June and Mid-August (S.E. = ±0·10)		Aphid Control as Percentage of Complete Control		Yield per Acre (S.E. = ±1·54) *cwt*
		Rothamsted	Woburn	Rothamsted	Woburn	Woburn only
Soil-treated ..	0·18	0·47	0·05	94	99	20·4
Seed-dressed ..	0·012	1·18	0·88	54	56	19·1
Seed-soaked ..	0·003	1·22	1·12	49	18	17·4
Foliage spray ..	0·001	0·39*	—	95	—	—
Untreated ..	0	1·51	1·20	0	0	16·0

*Excluding pre-spray population.

Yields were obtained only in the Woburn experiment and are given in Table 4. They reflect the degree of control of both *A. fabae* and *S. lineatus*, the yield of the soil-treated plots being significantly higher than that of the untreated.

The persistence of the different formulations in bean plants was checked using the sleeve method, and *M. viciae* as test insect. Young adults were sleeved on the top 2–3 inches of stem at intervals from 62 to 138 days after the seeds were sown on April 2. Ten *M. viciae* were used per sleeve and six sleeves per treatment. Treatments were : soil treatment (0·19 grammes demeton per plant); seed dressings (0·014 and 0·006 grammes per seed) and seed soaked (0·0037 grammes per seed). The number of live aphids in each treatment after one week's caging are shown graphically in Fig. 2 as percentages of the number in the untreated controls.

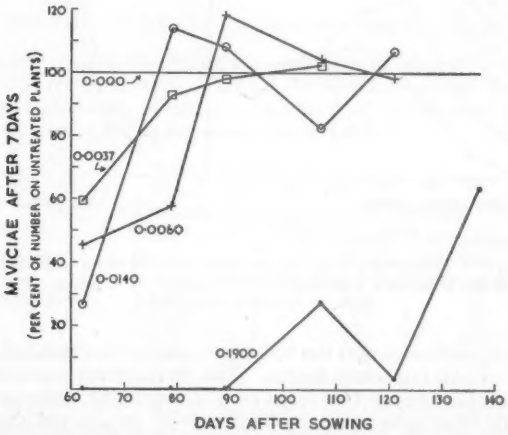

Fig. 2. Results of an experiment, using *M. viciae* caged at intervals on growing bean plants, to determine persistence of demeton applied to seed and soil at the time of sowing the crop. The figures are the doses of demeton in grammes per seed.

The soil treatment was the only one which killed all aphids 62 days after sowing, and it remained effective for over 120 days. The other treatments lost all toxicity after 80 days. These results indicate that the insecticide was less persistent than in the experiments with *A. fabae*. This, however, may be due to the different test insect and to the later sowing date.

CONTROL OF MYZUS PERSICAE ON POTATOES

Potatoes may be attacked by *M. persicae* as soon as the shoots are exposed, and a systemic insecticide applied at planting time need persist for less than a month to control the earliest infestation. It would need to remain toxic in the stem for 4–5 months to protect the crop throughout the season.

Demeton was applied as a 50 per cent dust scattered in the planting holes, the sowing date being May 12. There were five levels of dose ranging from 0·125 to 1·0 grammes demeton per tuber, and measurements of plant growth indicated that none was phytotoxic. Young *M. persicae* adults were sleeved on the stems at intervals from 42 to 112 days after planting and the live aphids in each treatment after one week's caging are shown graphically in Fig. 3 as

percentages of the number of aphids in the untreated controls. It can be seen that, 39 days after planting, all treatments effectively controlled *M. persicae* but after 112 days only the highest doses continued to give good protection.

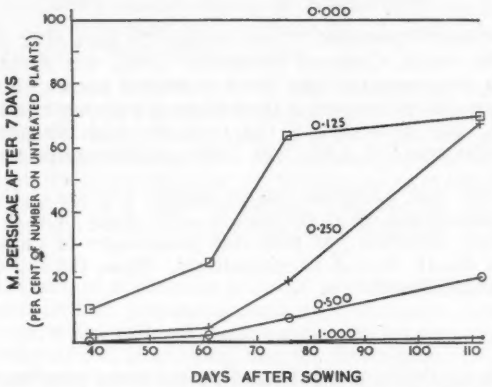

Fig. 3. Results of an experiment, using *M. persicae* caged at intervals on growing potato plants, to determine persistence of demeton put in the planting hole at the time of sowing the tubers. The figures are the doses of demeton in grammes per tuber.

When the plots were harvested on September 10, soil around some of the parent tubers was collected and, for every treatment, four lots of about 100 grammes soil were placed separately in flasks of culture solutions containing young bean plants. Twenty adult *M. viciae* were sleeved on each plant stem and after one week the live aphids were counted. There were 395 on plants treated with soil from the untreated plots, but none on any of the demeton treatments. Thus, even after four months much insecticidal material remained in the soil, and yet after the first few weeks the potato plants, except those treated with the highest doses, had stopped absorbing it in quantities sufficient to kill all aphids caged on the tops of their stems. Perhaps this was because the absorbing region of the plant's rooting system had spread beyond the region of the parent tuber where all the insecticide was concentrated.

The crop from the above experiment was stored until December 22 when eight tubers were taken at random from each treatment, washed thoroughly, and planted in pots of John Innes compost kept in a heated artificially-lit glasshouse. When the young shoots were an inch or two high each plant was infested with 10 adult apterae of *M. persicae* and the numbers of live aphids counted after one week were as follows :

Dose of Demeton Applied to Parent Tuber grammes/tuber	*M. persicae* Developing in One Week on Shoots of Daughter Tubers (Percentage of Number on Untreated Plants)
0	100
0·125	102
0·25	90
0·5	38
1·0	34

These results suggest that when the parent tuber is treated with a very high dose of demeton the insecticide may be translocated to, and stored by, the daughter

tubers in quantities sufficient to kill *M. persicae* on their young shoots. This experiment was not repeated and the result needs confirmation.

OBSERVATIONS ON OTHER POTATO PESTS

In the above field experiment, it was noticed 56 days after the tubers were planted that the mirid, *Calocoris norvegicus* Gmel. was damaging plants in untreated plots more severely than those in treated ones. About four adults and nymphs were sleeved on each of three stems in each treatment and examined four days later. For doses of 0, 0·125, 0·25, 0·5 and 1·0 grammes demeton per plant the kills were 0/9, 1/10, 2/10, 7/10 and 10/10 respectively.

When the crop was harvested, many healthy late instar Cutworm larvae (*Agrotis* spp.) were found on all treatments. For doses of 0, 0·125, 0·25, 0·5 and 1·0 grammes demeton per plant the percentages of damaged daughter tubers were 14, 10, 11, 20 and 15 respectively. Thus, the soil treatments did not affect larvae of *Agrotis* spp.

DISCUSSION

This work shows that spring bean and potato crops may be protected from aphid attack throughout the growing season by demeton dust drilled with the seed. However, the amounts of demeton needed are sometimes extremely high and seem to be both uneconomic and dangerous. For example, to control *A. fabae* on spring beans, a soil application at planting required about 180 times more demeton than a conventional foliage spray. High doses are needed when there is a long interval between sowing the seed and attack by the pest. This is partly because the demeton is diluted by plant growth and may be decomposed in the plant before the insect pest arrives (Metcalf *et al.*, 1954 ; Thomas *et al.*, 1955); also, there is evidence from the present work that the aerial parts of a plant can lose their toxicity though much demeton remains unabsorbed in the soil. Perhaps the absorbing region of the plant roots had spread beyond the region where the insecticide was concentrated.

The dose of demeton that can be applied as a seed dressing is probably inadequate for long lasting control though it is remarkable that a seed dressing of 0·012 grammes demeton per seed halved the population of *A. fabae* attacking beans three months after the treated seed was sown.

It is concluded from these experiments that soil and seed application of a systemic insecticide such as demeton at the time of planting is probably of limited use if a long-lasting effect is required in the aerial parts of the plant. There is, as mentioned by David and Gardiner (1955), a need for a systemic treatment to protect the young shoot of the plant immediately following its germination and appearance through the soil, especially as a conventional spray or dust treatment cannot always be timed to control this early attack. The success of *gamma*-BHC as a seed dressing for protecting brassica seedlings from flea beetle damage is seemingly due to a limited systemic action which controls the attacks which may occur as the seedling is emerging. Similarly a demeton seed dressing can stop early damage by *S. lineatus* to peas and beans.

Recent work has shown that the spread of some potato and sugar beet viruses is reduced if the aphid vectors are controlled with certain insecticide sprays. Sprays, however, are wasteful and have little persistence when applied to the rapidly-growing newly-emerged shoots. A seed dressing would give better

protection and would enable foliage sprays to be started only when there is an adequate plant stand.

The present work indicates that relatively small doses of a systemic insecticide such as demeton applied as a seed dressing can control early attacks of *S. lineatus* and *M. persicae* on beans and potatoes respectively. A seed dressing might also protect late-sown spring beans from *A. fabae*.

As stated by David and Gardiner (1955), the seed-soaking technique may be an efficient means of getting a systemic insecticide into the plant, but the present experiments with field beans indicate that, in practice, the amount absorbed is usually either inadequate or phytotoxic. More can be applied by seed dressing and soil treatments which are much less phytotoxic and have a further advantage that not all the insecticide is absorbed initially. Absorption may occur over a relatively long period, consequently giving longer protection to the aerial parts of the plant.

A serious disadvantage of demeton as a seed or soil treatment which virtually prohibits its use is its high mammalian toxicity. However, these experiments demonstrate the potential value of control measures using systemic insecticides applied to the seed or soil at planting, and the development of less poisonous chemicals such as methyl-demeton may perhaps make this treatment a practical control measure for some pests.

We are indebted to Dr. H. H. Mann for his help with experiments at Woburn.

REFERENCES

ANDERSSON, I. and OSSIANNILSSON, F. (1951). Försök med Pestox 3 som betningsmedel. *Växtskyddsnotiser, Stockh.*, Nos. 5–6, 84–8. (See *Rev. appl. Ent.* (*A*), 1952, **40**, 217.)

ASHDOWN, D. and CORDNER, H. B. (1952). Some Effects on Insect Control and Plant Response of a Systemic Insecticide Applied as a Spray, a Seed Treatment, or a Soil Treatment. *J. econ. Ent.*, **45**, 302–7.

DAVID, W. A. L. and GARDINER, B. O. C. (1955). The Aphicidal Action of Some Systemic Insecticides Applied to Seeds. *Ann. appl. Biol.*, **43**, 594–614.

DAVID, W. A. L. (1957). Insecticidal Action Studies with Demeton-O and Demeton-S. *Bull. ent. Res.*, **48**, 91–107.

METCALF, R. L., MARCH, R. B., FUKUTO, T. R. and MAXON, M. (1954). The Behaviour of Systox Isomers in Bean and Citrus Plants. *J. econ. Ent.*, **47**, 1045–55.

NEEDHAM, P. H. and WAY, M. J. (1955). Control of Pea Weevil (*Sitona lineatus L.*). *Rep. Rothamst. exp. Sta.*, 1954, 116–8.

THOMAS, W. D. E., BENNETT, S. H. and LLOYD-JONES, C. P. (1955). The Absorption, Breakdown and Systemic Behaviour in Plants of ^{32}P-labelled Demeton-S. *Ann. appl. Biol.*, **43**, 569–93.

UNTERSTENHÖFER, G. (1953). Field Tests with the Systemic Insecticide " Systox " Against the Bean Aphid (*Doralis fabae* Scop.) on Horse Beans (*Vicia faba* L.). *Höfchenbr. Wiss.*, **6**, No. 2, 121–30.

WAY, M. J., SMITH, P. M. and POTTER, C. (1954). Studies on the Bean Aphid (*Aphis fabae* Scop.) and its Control on Field Beans. *Ann. appl. Biol.*, **41**, 117–31.

THE OPTIMUM SIZE OF STICKY APHID TRAPS

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Sticky traps are often used to study the aphid vectors of plant virus diseases. They are mostly modelled on the cylindrical trap described by Broadbent, Doncaster, Hull and Watson (1948). Vertical and horizontal flat traps have also been used (Dickson, Johnson, Flock and Laird, 1956 ; Dudley, Searls and Weed, 1928 ; Broadbent, 1957), but little work to determine the optimum size for such traps has been reported. The traps used in my experiments were either vertical cylinders or horizontal surfaces of various practical sizes.

EXPERIMENTAL METHODS

Cylindrical sticky traps, made from 30-cm lengths of metal piping, 12·5 cm, 6·2 cm or 3·1 cm in diameter, were fixed to unpainted posts so that the bases of the cylinders were about one metre from the ground. The traps were either painted " Hansa " yellow, which was expected to attract aphids, or dull black, which was not expected to be attractive. Cylindrical covers of transparent plastic were coated with a layer of tree-banding grease about 2 mm thick.

The horizontal traps, resembling tables with slightly convex tops to allow rain to run off, were 70 cm from the ground. A sheet of plastic coated with grease was held in place by metal strips and covered a central yellow area 15 cm, 30 cm or 60 cm square ; the narrow surround and the frames were painted black.

The traps were erected about three metres apart over bare ground, and were cleared of insects at least twice a week. At the same time the traps were interchanged between sites, because any one site might have been particularly favoured by prevailing winds or by aphids flying from nearby crops.

RESULTS

Yellow cylindrical traps were operated between August 21 and October 9, 1952, a total of 13 trapping periods. During this time the weather was often unsuitable for aphid flight and few were caught. Table 1 shows that not only was the catch per unit area smaller on the larger traps, but that the total catch per trap did not differ significantly. *Brevicoryne brassicae* (L.) was the most numerous species trapped during this period, but as they appeared in only about half the catches, no significant difference could be shown between traps.

TABLE 1

APHIDS TRAPPED ON YELLOW CYLINDERS BETWEEN AUGUST 21 AND OCTOBER 9, 1952

Trap diameter	3 cm	6 cm	12 cm	Mean
Total catch	179	142	137	152·7
Total *B. brassicae*	141	82	95	106·0
Mean catch per trapping period (log $n + 1$) ($\pm$ 0·060)	0·72	0·87	0·71	0·76
Catch per unit area (compared with 3 cm diameter trap)	179·0	71·0	34·2	94·7

Even duplicate traps operating near one another at the same time catch very different numbers of aphids, and the numbers caught during different trapping periods vary greatly. As a fortuitously high catch on one trap may cause the arithmetic mean catch for that trap to be abnormally high, the results shown in Table 1 and in the following tables are in the form of geometric means, which have been shown by Williams (1937) to give more consistent results in comparisons of this nature.

Similar traps, but black, were operated between June 15 and August 28, 1954, that is, for 15 trapping periods. Many more aphids were caught than in the previous experiment. Table 2 shows that the 12 cm diameter trap caught significantly more aphids per trapping period than did the 6 cm trap, which caught significantly more than the 3 cm trap. However, the catch per unit area of trapping surface decreased with the increase in area. *Aphis fabae* Scop. were caught in fairly large numbers, and the numbers caught increased with the increase in trap diameter.

Table 2

Aphids Trapped on Black Cylinders between June 15 and August 28, 1954

Trap diameter	3 cm	6 cm	12 cm	Mean
Total catch	837	1,473	2,017	1,442·3
Total *A. fabae*	117	224	312	217·7
Mean catch per trapping period (log $n + 1$) ($\pm$ 0·048)	1·60	1·82	1·97	1·80
Catch per unit area (compared with 3 cm diameter trap)	837·0	736·5	504·2	692·6

Finally, having obtained conflicting results with black and yellow cylinders, a replicated trial was made with both yellow and black traps, exposed for 20 periods of 2 or 3 days, between June 13 and August 29, 1956. Two traps of each size and colour were used. A total of 7,119 aphids was caught, 3,528 on yellow traps, and 3,591 on the black. An analysis of the data showed that the mean catch per trapping period was significantly greater, at the 0·05 level, on 12 cm diameter traps than on 6 cm diameter traps, and that on 6 cm traps greater than on 3 cm traps ; also yellow traps caught significantly more than black traps of equivalent size. The mean numbers of aphids trapped are shown in Table 3. Again, the smaller traps caught more aphids per unit area than larger traps.

Table 3

Aphids Trapped on Yellow and Black Cylinders between June 13 and August 29, 1956

	Mean Catch per Trapping Period (log $n + 1$)			
Trap diameter	3 cm	6 cm	12 cm	Mean
Yellow traps	0·86	1·00	1·16	1·01
Black traps	0·80	0·95	1·06	0·94
Mean ($\pm$0·021)	0·83	0·98	1·11	0·97
Difference ($\pm$0·041)	−0·06	−0·05	−0·10	−0·07 ($\pm$0·024)

Horizontal sticky traps were operated between June 15 and August 24, 1954, a total of 15 trapping periods. The total numbers of aphids caught on the 225, 900 and 3,600 sq. cm traps were 229, 664 and 2,002 respectively. The mean catch per trapping period (log $n + 1$), on a unit area basis, for traps of increasing size was 1·84, 2·03, and 1·91, with a standard error of $\pm$ 0·028. The total numbers of aphids caught increased strikingly as trap size increased, but although the 60 cm square trap caught more aphids per unit area than the 15 cm square trap, the 30 cm square trap caught most.

The only species of economic importance common on traps during this period was *A. fabae*, and 31, 119 and 278 were caught by horizontal traps in order of increasing size.

It was not possible to analyse the distribution of individual species of aphids between traps, because the differences between traps of the same type were too great. For example, 1,002 *Cavariella aegopodii* Scop. were caught on one black 12 cm diameter trap, but they appeared in catches from only 7 of the 20 trapping periods, and on a similar trap only 128 were caught, from 11 of the 20 catches. Most of these aphids were caught during one period, possibly as a result of a single mass flight.

CONCLUSIONS

Many aphids are attracted to bright yellow (Broadbent, 1948 ; Moericke, 1950), but they can only fly to yellow traps under calm conditions because they cannot direct their flight at wind speeds above 1½ miles per hour. Broadbent (1948) found that about 70 per cent of the aphids caught on some 5-inch sticky cylindrical traps were on the half facing the wind, so that a large proportion of the aphids caught can be assumed to have been impacted by the wind. At wind speeds above 1½ miles per hour aphids are blown like inanimate particles, and although particles suspended in air as it sweeps past a cylinder may collide with it, some will pass by in the divided air stream. Gregory (1951) studied *Lycopodium* spores deposited on sticky cylinders in a wind tunnel, and found that the number of spores trapped per unit area increased as the wind speed increased and as cylinder diameter decreased.

By analogy, therefore, narrow cylindrical traps might be expected to catch more aphids than wide in windy weather, and they did so during the 1952 experiment. Throughout the main period of aphid flight however, during 1954 and 1956, wide traps caught more than narrow ones, although doubling the surface area of the trap did not double the catch. This decrease in catch per unit area with increase in trap size was found with both yellow and black traps.

Yellow traps caught significantly more aphids per trapping period than black traps of similar size, as had been shown by Broadbent (1948), but large black traps caught more than smaller yellow ones.

Square horizontal traps caught increasing numbers of aphids with increase in size, but the catch per unit area was greatest on the 900 sq. cm trap, and least on the 225 sq. cm trap. Dickson, Johnson, Flock and Laird (1956) found that large vertical sticky boards (600 sq. in.) were relatively less efficient at trapping aphids than small boards (50 sq. in.).

Alate aphids, even though few, may be important vectors of virus diseases if they are active and infest many plants, and it is better to use large sticky traps than small, for they catch more aphids, even though they catch fewer per unit area. Under field conditions it is difficult to handle sticky trap covers much above 50 cm square, especially in high winds, and under some conditions water traps are more satisfactory than sticky traps for detecting aphids when there are few in the air (Heathcote, 1957).

REFERENCES

BROADBENT, L. (1948). Aphis Migration and the Efficiency of the Trapping Method. *Ann. appl. Biol.*, **35**, 379–94.

BROADBENT, L. (1957). *Investigation of Virus Diseases of Brassica Crops.* Cambridge University Press.

BROADBENT, L., DONCASTER, J. P., HULL, R. AND WATSON, M. A. (1948). Equipment Used for Trapping and Identifying Alate Aphids. *Proc. R. ent. Soc. Lond.*, (*A*), **23**, 57–8.

DICKSON, R. C., JOHNSON, M. McD., FLOCK, R. A. and LAIRD, E. F. (1956). Flying Aphid Populations in Southern Californian Citrus Groves and their Relation to the Transmission of the Tristeza Virus. *Phytopathology*, **46**, 204–10.

DUDLEY, J. E. JR., SEARLS, E. M. and WEED, A. (1928). Pea Aphid Investigations. *Trans. 4th Int. Congr. Ent. Ithaca, N.Y.*, **2**, 608–21.

GREGORY, P. H. (1951). Deposition of Air-borne *Lycopodium* Spores on Cylinders. *Ann. appl. Biol.*, **38**, 357–76.

HEATHCOTE, G. D. (1957). The Comparison of Yellow Cylindrical, Flat and Water Traps, and of Johnson Suction Traps, for Sampling Aphids. *Ann. appl. Biol.*, **45**, 133–9.

MOERICKE, V. (1950). Über den Farbensinn der Pfirsichblattläus *Myzodes persicae* Sulz. *Z. Tierpsychol.*, **7**, 265–74.

WILLIAMS, C. B. (1937). The Use of Logarithms in the Interpretation of Certain Entomological Problems. *Ann. appl. Biol.*, **24**, 404–14.

CEREAL ROOT EELWORM IN DURHAM, 1955

by J. H. WHITE

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There has been considerable overcropping of oats in east and central Durham in recent years (McLeod *et al.*, 1954). This has led to an increase in the prevalence of Stem and Bulb eelworm, *Ditylenchus dipsaci* (Kühn) Filipjev, which was assessed in a survey in 1951. During this survey 116 oat crops were examined and Cereal Root eelworm, *Heterodera major* (O. Schmidt) Franklin was recorded on a number of fields but was considered of minor importance. During 1954, however, a number of cases were investigated where *H. major* alone was causing severe yield loss and it was considered worth while to carry out a further survey to determine the distribution and abundance of this pest in a limited area of County Durham.

In July 1955, all of the oat crops growing in the parishes of Pittington, Kimbleworth, Sherburn, Witton Gilbert, Bearpark, and Spennymoor were sampled for Cereal Root eelworm. The survey method differed in some degree from that used during a national survey carried out in 1954 (Southey, 1955). A four-inch length of drill was lifted at each of 20 sampling stations in a diagonal across each field. Each drill sample was examined visually in the field in turn until eelworm was detected. It follows that all 20 samples were examined in fields finally classed as uninfested. Although drill sample examination ceased on confirming the presence of eelworm, any patches in the field were examined to see whether or not the pest was responsible for the reduced plant vigour.

SURVEY RESULTS

Cereal Root eelworm was found to be more widespread than was anticipated. Of the 197 fields examined, 108 (55 per cent) were infested, and patchiness, certainly due to eelworm, was found on 35 of them. In the 108 fields on which

eelworm was found, an average of 6 samples were examined before the first cysts were seen. This compares with an average of 4 samples examined before cyst detection on the 35 patchy fields, and an average of 7 samples on the 73 fields where eelworm was not present in sufficient numbers to cause a noticeable effect on the crop. Clearly there is a correlation between the rapidity with which eelworm is found and the degree of infestation as shown by crop response. In this connection it should be recalled that Stone (1956) suggested that where high densities are present, cyst distribution tends to even out over the field. The present results seem to confirm this.

The surveyed fields were distributed over 56 farms and, in the table below, eelworm infestation is analysed in relation to the number of oat crops grown on each farm.

Number of Infested Fields on the Farm	Number of Oat Crops on the Farm								Total
	1	2	3	4	5	6	7	8	
0	2	3	3	2	0	0	0	0	10
1	5	2	2	2	2	1	1	0	15
2		4	4	1	1	1	0	0	11
3			7	3	2	0	1	0	13
4				1	1	1	0	1	4
5					2	0	0	0	2
6						0	0	1	1
Number of farms in each class	7	9	16	9	8	3	2	2	56

It should be noted that the number of oat crops on a given farm is an indication of the size of the farm rather than the frequency of oat cropping reflected by eelworm density. If the farms are divided arbitrarily into two groups in which large farms have more than, and small farms less than, four oat crops it is clear that 16 out of 32 of the small farms had all their 1955 oat fields infested compared with 3 out of 24 of the larger holdings. This suggests that Cereal Root eelworm is particularly a pest of the smaller farms. On these holdings of limited arable acreage it is difficult to ensure that sound rotational practices are adopted; susceptible crops, particularly oats, are grown too often with the result that eelworm density has increased to the point where it is a limiting factor in oat yield.

REFERENCES

McLEOD, K., GOLIGHTLY, W. H. and PRICE, C. D. (1954). " Tulip Root " of Oats in Durham. *Agriculture*, **61**, 229–31.

SOUTHEY, J. F. (1955). Survey of Cereal Root Eelworm in England and Wales, 1954. *Plant Pathology*, **4**, 98–102.

STONE, L. E. W. (1956). Cereal Root Eelworm : A Farm Survey. *Plant Pathology*, **5**, 24–5.

THE CONTROL OF CABBAGE ROOT FLY IN SEEDBEDS

by W. I. St. G. Light and B. D. Moreton

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Cauliflower (Veitch's Autumn Giant) was sown on May 11, 1956 at Woodchurch Farm, Birchington, Kent, in plots of three parallel drills, each 1 yard long, at a rate of 4 lb seed per acre. Treatments, shown in the table, were replicated four times in a randomized block design. Broadcast insecticides were cultivated in to a depth of 2–3 inches just before sowing. The centre row of each plot was lifted on July 11, and the plants classified as sound, damaged but fit for planting, and severely damaged. The results have been transformed to angles for analysis, the percentages shown in the table being the detransformed mean values for each treatment.

Treatment	Sound Plants	Total Damaged Plants		Severely Damaged Plants	
	Mean of 4 plots	Angular Values	Detransformed Mean *per cent*	Angular Values	Detransformed Mean *per cent*
Aldrin:					
In seedbed ..					
2·8 lb per acre ..	71·5	9·3	2·6	3·3	0·3
5·6 lb per acre ..	65·8	0·0	0·0	0·0	0·0
1¼% dust in drills					
0·5 oz per 10 yd ..	72·5	5·4	0·9	3·4	0·4
1·0 oz per 10 yd ..	64·5	2·0	0·1	2·0	0·1
Dieldrin:					
In seedbed					
2·8 lb per acre ..	62·8	18·8	10·4	6·2	1·2
1¼% dust in drills					
0·4 oz per 10 yd ..	58·3	26·5	19·9	18·8	10·4
0·8 oz per 10 yd ..	59·8	14·2	6·0	7·0	1·5
Dipterex:					
50% product in drills					
0·38 g per 10 yd ..	13·0	48·7	58·4	38·8	39·3
Untreated controls ..	36·8	41·6	44·1	26·8	20·3
Least significant difference:					
P = 0·05	24·5	13·8		9·6	
P = 0·01	33·2	18·7		13·1	
P = 0·001 ..	44·4	25·1		17·5	

All the aldrin and the broadcast dieldrin treatments gave significantly more sound plants than the controls, and although differences between these treatments were not significant there was a suggestion that those based on aldrin were better. Aldrin broadcast at 2·8 lb per acre is equivalent to 2 cwt of 1¼ per cent aldrin dust, which is a little more than the commercial recommendation of 1½ cwt (2·1 lb aldrin) per acre. Aldrin applied in the drills at 0·5 oz per 10 yards is equivalent to about ½ cwt of 1¼ per cent dust per acre, and used in this way it would be more economical as well as better from a biological point of view.

OPOMYZA FLORUM ON EARLY-SOWN WINTER WHEAT

by D. B. SLOPE

Rothamsted Experimental Station, Harpenden, Herts

In 1956 and 1957, in experiments at Rothamsted comparing the effect on yield of sowing Capelle wheat on four different dates and at three different rates, the plants were attacked by shoot-boring larvae identified as *Opomyza florum* Fabr., a dipterous insect whose larval stages and life history have been described by Thomas (*Ann. appl. Biol.*, 1933, **20**, 707–21). Eggs are laid on the soil near wheat seedlings in early autumn and hatch in March or early April of the following year. The larvae enter, and feed on, the central tissues of tillers, which are eventually killed. Pupation takes place in the plant during the second half of May and the adults emerge in June.

The incidence of *O. florum* on the wheat sown at four dates each year, as determined by sampling the plants in six 1-foot lengths of drill on May 1, 1956, and twelve 1-foot lengths on April 2, 1957, was as follows :

Date of Sowing	Wheat Emerged	Plants Infested *per cent*	Shoots Infested *per cent*	Estimated No. of Larvae *per acre*
1955 Sept. 27	Oct. 9	27·6	8·0	433,000
Oct. 18	Nov. 4	3·9	1·2	60,000
Nov. 10	Dec. 9	nil	nil	nil
Dec. 2	Jan. 2	0·2	0·1	2,000
1956 Sept. 18	Sept. 27	82·8	36·4	1,456,000
Oct. 15	Nov. 2	31·5	8·6	373,000
Nov. 8	Dec. 10	7·0	1·9	75,000
Dec. 4	Jan. 1	4·7	1·6	60,000

A much higher proportion of plants were infested in 1957 than in 1956, but in both years the attack was heaviest on the September-sown wheat and became progressively less the later the wheat was sown. However, wheat sown in September or October is well developed by the time the eggs hatch in the spring and normally only the late-produced side tillers are attacked. For this reason even a heavy infestation may not reduce yields seriously. In fact, the wheat sown in September 1956 yielded nearly a ton per acre more grain than that sown in December, the gain by early sowing thus being much greater than any loss caused by *O. florum*. Yields for 1957 are not yet known but, in spite of the very heavy attack, there was an average of 33 undamaged shoots per foot of row on the September-sown crop when sampled on April 2, probably enough to give a good crop. Differences in seed rates had little effect on the incidence of the pest.

I am indebted to Mr. P. Aitkenhead and Mr. R. A. French for confirming the identification of the larvae.

AN ERIOPHYID MITE CAUSING DAMAGE TO CHRYSANTHEMUMS

by J. D. R. VERNON*

National Agricultural Advisory Service, Wolverhampton

In 1954 and 1955 considerable damage, associated with a species of Eriophyid mite, occurred in the autumn on chrysanthemums under glass at Mere, Cheshire. Dr. A. M. Massee identified the species as *Epitrimerus alinae* Liro, 1941, originally found on chrysanthemum leaves in Finland. Morison recorded similar damage by Eriophyid mites on chrysanthemums in Scotland in 1949 (*Trans. R. Highl. agric. Soc. Scot.*, 1950, **62,** 60–4), and this would seem to be the first published record in the United Kingdom. However, Hodson reported damage to chrysanthemums by an unknown species of Eriophyid at Hampton, Middlesex, in 1930. Subsequent reports include Eriophyid mites as present on chrysanthemums from five nurseries in the West Midlands, and also at Keighley, Yorks "apparently causing deformed flowers on var. Monument" in December 1951. In November 1952, they were noted from nurseries at Sewerby and Boroughbridge, Yorks. In 1954, I found *E. alinae* on chrysanthemums in one nursery in Staffordshire and in another in Shropshire. The species may prove to be generally distributed in Britain, and could become a serious pest.

At Mere, in 1954, mites were present in large numbers amongst the hairs on the stems of the chrysanthemums. The majority were 3–6 inches below the florets. Feeding of the mites caused a russeting of the stems and where this occurred at the bases of the upper petioles there was noticeable drooping of the leaves, and in some varieties a premature leaf drop. Varieties Fiona, Golden Seal and Corallia were the most severely affected. Mites also occurred on the upper leaf surface, but in much fewer numbers and generally scattered. Where the russeting of the stems was severe, the mites tended to migrate into and amongst the sepals and florets. In 1955, symptoms of attack were less severe. No russeting occurred, but on a local white variety the presence of mites is thought to have been associated with the poor quality of the blooms.

A spray of chlorobenzilate was tried against the mite at Mere in 1954, but with little success. This may have been due to the inefficiency of the wetter. Lime sulphur had been used by the grower as a fungicide on the affected chrysanthemums, but this did not appear to prevent a build up of mites. Sulphur dusts are known to give good control of the Eriophyid, *Vasates lycopersici* (Massee), (Anderson, L. D., *J. econ. Ent.*, 1954, **47,** 1001–5).

In 1955 a number of the plants were sprayed with metasystox (12 ounces to 100 gallons). One stem from each of eight sprayed and unsprayed plants was examined in the laboratory five days after spraying. No living, but numerous dead mites were found on the stems from treated plants, whereas the untreated stems were infested with an average of 72 live mites (range : 30–130) on the top 6 inches.

Thanks are due to Mr. E. C. Herwin for his interest and help in this work.

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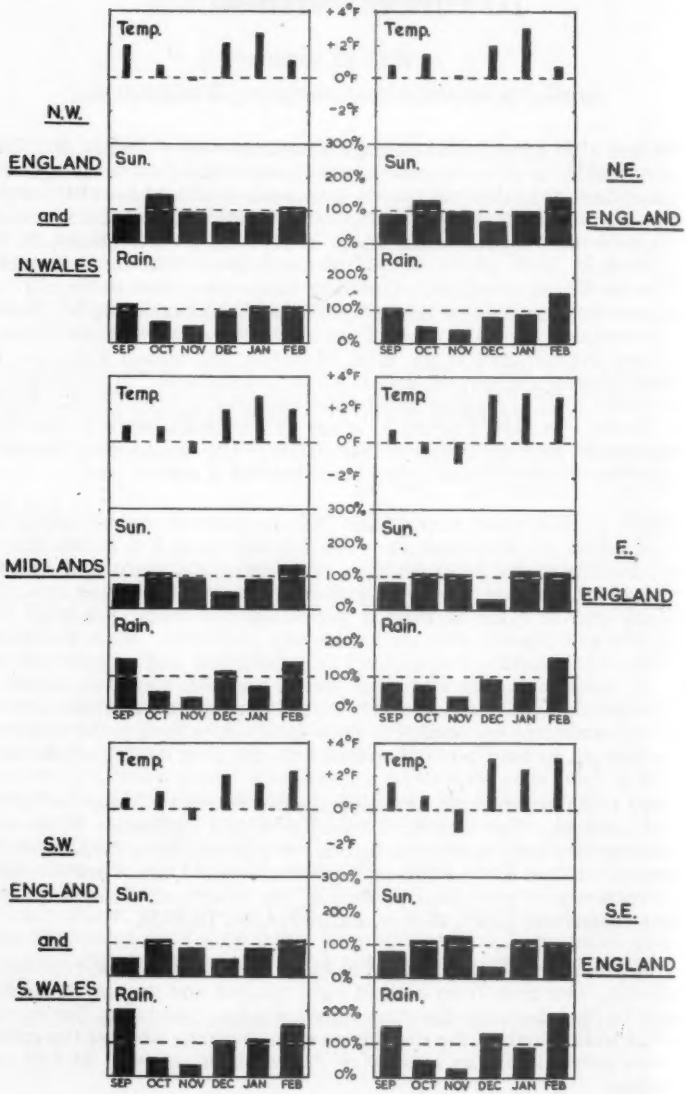
SEPTEMBER-FEBRUARY WEATHER 1956-57

Variations from average



THE WEATHER OF ENGLAND AND WALES*

AUTUMN AND WINTER 1956–57

Following a very cool and wet summer, September 1956, began to show signs of an improvement in the weather. It was very wet in the first week but subsequently much less rain occurred, especially in the east. Temperatures were generally above average, and despite the fact that there were more fogs than usual, gales were reported on several days, being widespread on the 28th.

The improvement continued in October which was a dry and sunny month in most areas ; fogs were fairly common at night. This dry weather continued into November when rainfall amounts were low almost everywhere : the general precipitation over England and Wales was estimated at 37 per cent of normal. There were two very cold spells towards the end of the month, and night minima of less than 20° F were reported from East Anglia and the Midlands.

Rainfall in December was nearly normal and the month as a whole was dull and mild with a short period of snowy weather around Christmas. This mild weather continued without any appreciable break for the rest of the winter months. In east and south-east England the winter ranks as one of the mildest of the century. Rainfall and sunshine were about average in January but February was a wet month with a high proportion of sunny periods. Soil temperatures were very much above the average by the end of the winter.

The weather for each of the six months from September to February (inclusive) is represented graphically on page 112. Figures for the six districts of England and Wales are shown in terms of the deviation from the average of air temperature, sunshine and rainfall. The two outstanding features are clearly the dryness of the late autumn and the persistent mildness of the winter, especially in the parts of England nearest the Continent.

NEW OR UNCOMMON PLANT DISEASES AND PESTS

***Centrospora acerina* on Carrot.** Licorice Rot of carrots, caused by *Centrospora acerina* (Hartig) Newhall, was found on specimens from a market garden near Edinburgh in the spring of 1957. The crop had been sown in March 1956 and was left in the ground over winter. On lifting in the following April about 5 per cent of the roots were affected. No celery or other known host of the fungus had been grown in the field previously. This appears to be the first record of the fungus in Scotland. The observation was made during my work as a Colombo Plan trainee, at Scientific Services, East Craigs, Edinburgh.

S. N. S. SRIVASTAVA

* These notes, and the diagram on page 112, are provided by the Agricultural Branch of the Meteorological Office and published by permission of the Director General.

***Siteroptes graminum* in Scotland.** In a varietal trial of oats laid down by the West of Scotland Agricultural College in 1956, it was observed in August that damage to the heads had occurred involving 2 to 5 per cent of all spikelets. Examination of a sample showed that a large number of mites were present on the inner surface of the pales and on the outer surface of the kernel. There was also a brown discoloration of the pales. The mites were identified as *Siteroptes graminum* (Reuter) and adult non-gravid females, males and larvae were present. The identification was confirmed by Dr. G. O. Evans of the British Museum. The stems were also examined but no evidence of adult mites or larvae was found. The species was first recorded in Britain in 1944 (Massee, A. M., *Rep. E. Malling Res. Sta.*, 1943, 65) but there does not appear to be any previous record of the mite in Scotland. The mite has been recorded from various European countries. The occurrence on wheat in Spain reported in 1946 (Alfaro, A., *Bol. Pat. veg. Ent. agric. Madr.*, **14**, 321–34) was associated with the fungus *Nigrospora oryzae* and contributed, with unfavourable climatic conditions, to a crop failure. The association of the mite with " bud-rot " of carnation is well known (Cooper, K. W., *Phytopathology*, 1940, **30**, 853–9) and, under certain conditions, the mite may also become a serious pest of cereals, particularly as a carrier of fungal disease.

S. MILNE

Acid damage simulating Pink Rot in Potatoes. In October 1956, a sample of Red King Edward potatoes was received from Mr. J. C. F. McIntyre, County Agricultural Adviser for Fife, from a farm near Cupar. The tubers were rather soft and rubbery, but without the typical bacterial soft rot smell, and of quite abnormal colour—a lustreless uniform orange-pink which tended to leach out of the skin. The consistency of the flesh of the tubers was similar to that of Pink Rot, and fears were expressed as to the keeping quality of the crop in view of the widespread incidence of Pink Rot in 1955. There was, however, little discoloration on cutting, and no evidence of mycelium in the tissues. The potatoes came from an apparently normal area near a headland, and it seemed possible that they had been damaged by an excess of the concentrated sulphuric acid used for haulm destruction, due to leakage from the sprayer nozzles while the machine stood at the edge of the field. To test this, normal tubers from the same crop were placed in 10-inch pots under about 5 inches of soil, and after watering, 400 ml of concentrated sulphuric acid was poured on to the soil surface. On examination after 7 days the tubers were in a condition identical with that of the affected potatoes taken from the field. The pH of the flesh varied from 2·2 in the outer cortex to 1·1 in the pith. In another experiment three tubers covered with soil saturated with acid diluted with an equal volume of water showed the same effect after 24 hours.

A. E. W. BOYD

Damage to Gooseberry by *Orthosia gothica*. Economic damage by the larvae of the Hebrew character moth, *Orthosia gothica* (L.) is rare. Vappula (*Notul. ent., Helsingf.*, **15**, 37–9) reports its occurrence on black currant in north Finland and Reichert (*Kranke Pflanze*, **13**, 139–40) records its feeding on the leaves of plum in Saxony with an editorial note giving pear and apple as a larval host in Germany. Severe defoliation occurred on several gooseberry bushes in an Aberdeen garden in early July 1956, which, when noted, was thought to be due to Gooseberry sawfly larvae. Closer examination revealed 20–30 lepidopterous larvae per bush. A series collected, pupated in the laboratory at Marischal College between July 19 and 23, and definite identification was established on the emergence of adults between April 8 and May 9, 1957.

M. W. SHAW AND R. M. ALLAN

(70114) Wt. 24 K.9 9/57 Hw.